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# WOODWORK FOR SCHOOLS

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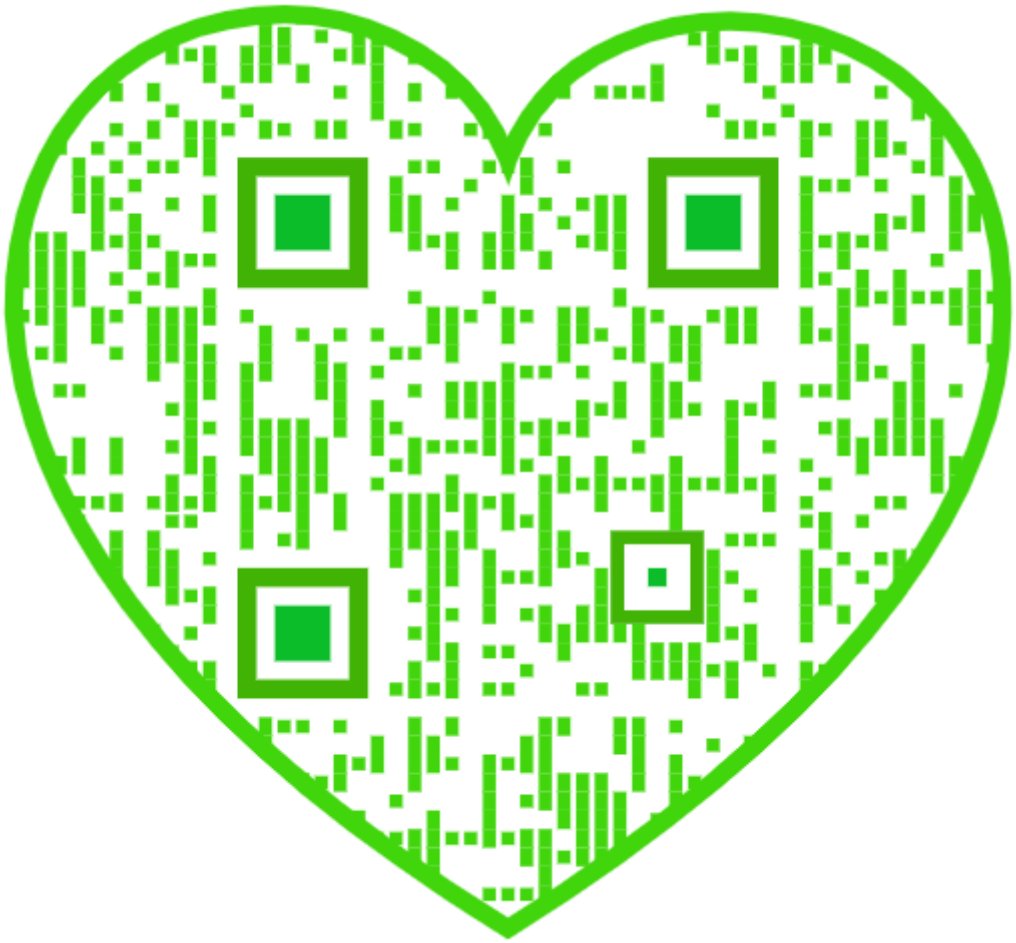

# WOODWORK FOR SCHOOLS

# WOODWORK FOR SCHOOLS

## ON SCIENTIFIC LINES

A COURSE FOR CLASS WORK OR PRIVATE STUDY

BY JAMES THOMAS BAILY

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IN THREE PARTS

PART I.

THE MANUAL ARTS PRESS, PEORIA, ILLINOIS

1909

# PREFACE

It has been evident for some time that if manual training is to take its proper place among the other subjects of the school curriculum it must be taught by methods which, while giving due prominence to the practical usefulness of the subject learned, will develop the general intelligence of the pupil.

This is the aim the authors have kept steadily in view throughout the book. By linking the classroom with the laboratory and workshop they have provided the pupil with a course of manual work which will increase his stock of general information, and at the same time make it evident that the knowledge acquired is capable of producing visible results of a useful and valuable kind.

The construction of science models, which forms an important portion of this course, has been found to lead to exceptionally good and careful work, especially in the case of boys in secondary schools, who have to use the apparatus afterwards.

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The pupil should keep a notebook in which to record his observations and answers to the questions. The master should make a point of examining these books every week.

It is hoped that candidates for the Examinations of the City and Guilds of London Institute, the Board of Examinations of the Educational Handwork Association, and the National Union of Teachers will find the book of great service in preparing for the Manual Training Certificates.

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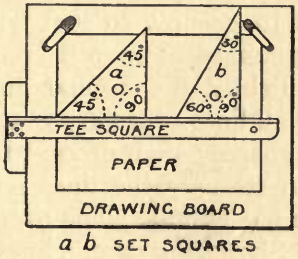
# WOODWORK FOR SCHOOLS

## HINTS FOR DRAWING.

FASTEN the paper on the drawing-board so that the edges of the paper are parallel to the edges of the board.

When using the tee-square keep its head in close contact with the left-hand edge of the drawing-board, using the top edge of the blade




*a b* SET SQUARES

FIG. 1.

as a guide to draw all horizontal lines. In projection drawing draw all perpendicular lines with the aid of the set-square, sliding it along the top edge of the tee-square blade. (See Fig. 1.)

The pencil should be chisel-pointed to draw lines (see Fig. 2), and round-pointed for lettering, figuring, sketching, etc.

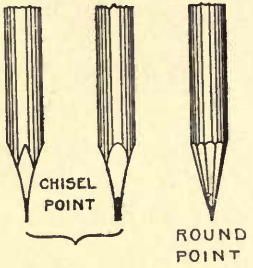



FIG. 2.

The following order should be adhered to in executing the drawings:

1. Plot out the space the drawing or set of drawings is to occupy, so that when completed it shall be symmetrical upon the paper.

2. Draw lightly the ground line, XY, when needed, and all lines necessary to the construction of the main shapes; then proceed to details.

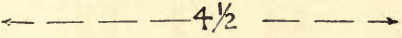
3. Line in strongly the lines representing the views of the model only, going over all circles and curves first. Show construction lines and projectors by chain lines, thus:

— · — · — — · — · — · — · — · —

and invisible edges of the model by short dotted lines, thus:

. . . . . .

4. Complete the drawing by neatly printing the title and the name of each view, and clearly mark all dimensions, thus:




The alphabet and figures given below may be copied, or any plain lettering used.

A B C D E F G H I J K L M N O P Q R
S T U V W X Y Z 0 1 2 3 4 5
6 7 8 9

NOTE.—*The sizes given for the wood required for each exercise are sawn sizes—that is, a little has been allowed for planing up and squaring the ends.*

# PART I

## LESSON 1.

### Short Straight-Edge.

*Drawing.*—Draw the XY line midway between the top and bottom edges of the paper; with the ruler measure off the length 10″, and at each end

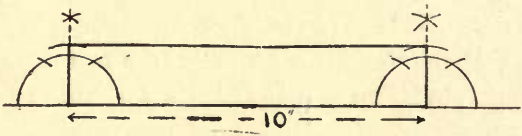



Fig. 3.

erect the perpendiculars with the aid of the compasses and ruler. (See Fig. 3.)

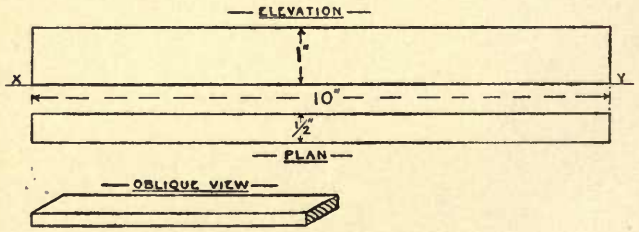



Fig. 4.

On each of these perpendiculars find a point 1″ from the XY, and connect the two points. The

oblong 10″ × 1″ thus obtained is the elevation of the straight-edge.

Draw the plan of the model showing the thickness ½″ in a similar manner (Fig. 4).

The oblique view is not to be drawn.

## Woodwork.

### MATERIAL REQUIRED.

| Description. | Quantity. | Size. |
|---|---|---|
| Yellow deal ... | 11″ | 1½″ × 1″ |

### Method of Planing up a Piece of Wood.

(*This method must be strictly adhered to in all the following Exercises.*)

1. Plane the face side true.

2. Plane the face edge straight and square to the face side, and inscribe the face marks.

3. Gauge and plane to width. (In this case the width is 1″.)

4. Gauge and plane to thickness. (In this case the thickness is ½″.)

5. Mark off the length with try-square and marking-knife, and cut off waste ends with tenon-saw.

### Questions.

1. On completing Exercise 1 measure accurately its length, width and thickness, and write these dimensions in your notebook.

2. Briefly describe the English system of measurement of length.

## LESSON 1a.

Draw a square piece of wood of 10 cm. side. Prepare such a piece with the plane and saw, and cut from this two equal triangular pieces of wood. Measure length of sides and enter in your notebook.

## LESSON 2.

PAIR OF WINDOW-WEDGES.

*Drawing.*—With the additional aid of a model,

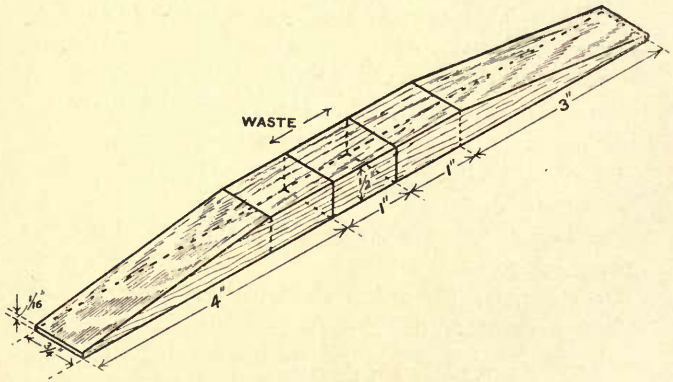



FIG. 5—PAIR OF WINDOW-WEDGES.

draw front elevation and plan, full size. Draw a freehand sketch of one wedge.

## Woodwork.

### MATERIAL REQUIRED.

| Description. | Quantity. | Size. |
|---|---|---|
| Yellow pine ... | 10″ | $1\frac{1}{4}'' \times \frac{3}{4}''$ |

### Questions.

1. Measure accurately the length and width of the chisel-pared surface of both wedges; compare the measurements with the corresponding dimensions on your drawing, and write the result in your notebook.

2. Write what you know about a lead-pencil. Give the names of each of its parts, and state if you think they are rightly named; if not, why?

## LESSON 2a.

Draw a triangle on a piece of wood having two sides, each 10 cm. long. Cut this triangle out. Drop a perpendicular from the apex to base, and saw down this line.

Find what relation the parts cut bear to each other, and hence give your conclusions as to what the perpendicular has done to the base of the original triangle.

## LESSON 3.

### PLANT-LABEL.

*Drawing.*—Draw full size front and side elevations, and make a freehand sketch of the oblique view. A model of the label may be used to draw from.

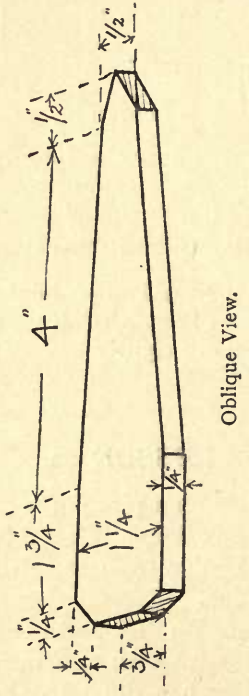



FIG. 6.—PLANT-LABEL.

### Woodwork.

MATERIAL REQUIRED.

| Description. | Quantity. | Size. |
|---|---|---|
| Yellow deal ... | 8″ | $1\frac{3}{4}″ \times \frac{1}{2}″$ |

### Questions.

1. Make a freehand sketch of a jack-plane, and write against it the names of its different parts.

2. What units in the British system of measurement are used to measure superficies?

## LESSON 3a.

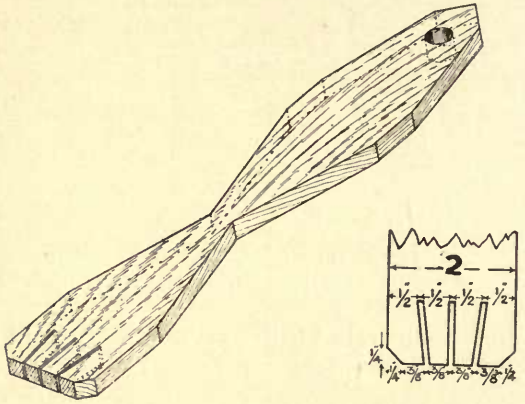
Plane all the sides and carefully square the ends of two pieces of wood to sizes of $6″ \times 1″ \times 1″$, and then let one stand on the other. Measure by aid of a protractor the angles the piece standing upright (vertically) makes with the piece lying flat (horizontally). Enter in your notebook the result obtained.

## LESSON 4.

### String-Holder.

*Drawing.*—Draw front and edge views to scale of half the full size—that is, so that 6″ shall

represent 1 foot—and draw full size sufficient of the lower end to show clearly the saw-kerfs.




Enlarged detail of lower end, showing saw-kerfs.

FIG. 7.—STRING-HOLDER.

## WOODWORK.

### MATERIAL REQUIRED.

| Description. | Quantity. | Size. |
|---|---|---|
| Whitewood ... | 13″ | $2\frac{1}{2}″ \times \frac{1}{2}″$ |

NOTE.—Cut the saw-kerfs with the hand-saw.

### Questions.

1. What is an exogen? Draw a cross section of an exogenous tree-stem, and name the different parts.

2. What was the superficial area of the piece of wood used for Lesson 4 when it was cut off to its length?

## LESSON 4a.

Cut out a triangular piece of wood—length of base 7·5 cm., and two angles at the base of 45 degrees. Measure the third angle by aid of protractor, and enter this, together with the sum of all the angles, in your notebook. What useful geometrical instrument have you made, and what have you learnt about the sum of the angles of a triangle?

## LESSON 5.

### Small Wall-Bracket.

*Drawing.*—A perspective view and a side elevation of the bracket are shown. Draw front elevation and plan, taking off your measurements from the dimensioned model given out to you. The side elevation shows how two supports of

Venetian strip-iron may considerably strengthen the shelf.

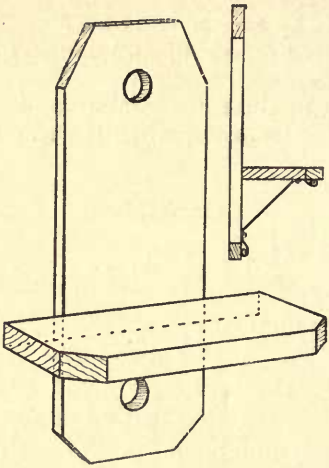


FIG. 8.—SMALL WALL-BRACKET (PERSPECTIVE VIEW)

## WOODWORK.

### MATERIAL REQUIRED.

| Description. | Quantity. | Sizes. |
|---|---|---|
| Yellow pine ... ... | 13″ | 3″ × $\frac{5}{8}$″ |
| Iron flat-headed screws | 2 | 1″ *No. 8* |
| Venetian strip-iron ... | 9″ | $\frac{3}{8}$″ or $\frac{1}{4}$″ |
| Round-headed screws | 4 | $\frac{1}{4}$″ |

### Questions.

1. What are the chief characteristics of the class of trees known as 'Conifers'? Give a list of trees belonging to that class, and the names of any places you know in which they grow.

2. If $\frac{1}{2}''$ yellow pine is sold at 3d. per superficial foot, what is the value of the piece used for Lesson 5?

## LESSON 5a.

### Cube, Square Prism, and Square Pyramid.

*Drawing.*—Make plans and elevations of a cube, square prism, and square pyramid.

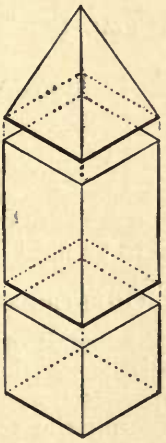



Fig. 9.—Geometrical Models (Isometric Views).

*Benchwork.* — Work the three models on one piece of wood, as shown by Fig. 9.

## LESSON 6.

### Notching Exercise.

*Drawing.*—Copy the given elevation full size, and from it project its plan. The exercise is to finish $\frac{3}{4}''$ in thickness.

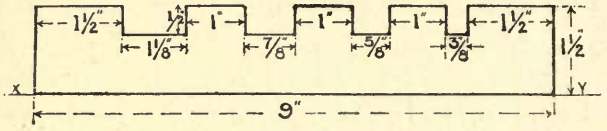



Fig. 10.—Notching Exercise (Face View).

### Woodwork.

MATERIAL REQUIRED.

| Description. | Quantity. | Size. |
|---|---|---|
| Yellow deal ... | 10″ | $1\frac{3}{4}'' \times 1''$ |

Retain Lesson 6 to be used in Lesson 7.

### Questions.

1. Give a short account of yellow deal and yellow pine; especially mention their appearance and chief points of difference.

2. Find out by using the scales the weight of your model (Lesson 6), giving your answer in the English system.

3. Describe the English units of weight, and those corresponding in the Metric System.

## LESSON 6a.

### TRIANGULAR PRISM, TRIANGULAR PYRAMID, AND TETRAHEDRON.

*Drawing.*—Make plans and elevations of a triangular prism, triangular pyramid, and a tetrahedron.

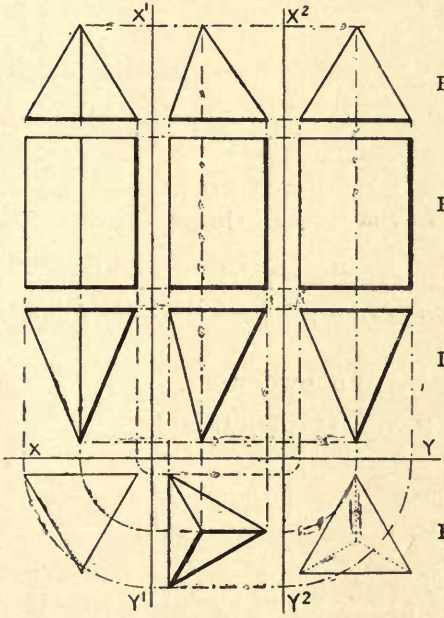



FIG. 11.—GEOMETRICAL MODELS.

*Benchwork.*—Work the three models on one piece of wood, as shown by Fig. 11.

## LESSON 7.

### CHISEL-RACK.

*Drawing.*—A model of the chisel-rack will be given to you. Make a rough dimensioned sketch

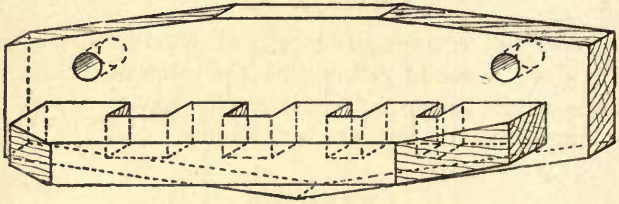


FIG. 12.—CHISEL-RACK.
View in oblique projection.

of the same, return the model to its place, and from the sketch draw a plan and elevation full size.

### WOODWORK.

MATERIAL REQUIRED.

| Description. | Quantity. | Sizes. |
|---|---|---|
| Exercise 6 for shelf ... | — | — |
| Yellow pine for back ... | 11″ | $3\frac{1}{2}″ \times \frac{5}{8}″$ |
| Oval wire nails ... | 5 | 1″ |

The two pieces are to be glued and nailed together.

QUESTIONS.

1. Draw a sketch of and describe the try-square.
2. What is glue? Describe how you would prepare it, and what precautions you would take in using it.

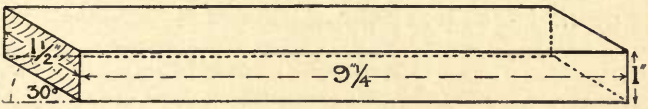
## LESSON 7a.

Work two rectangular blocks of wood to size of 3″ × 3″ × 2″—one of yellow pine, the other of yellow deal—weigh them, and explain why, having equal volumes, they do not weigh the same.

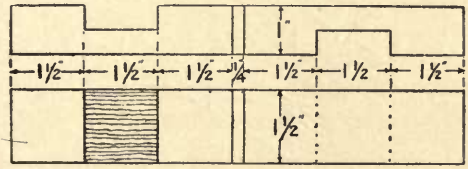
## LESSON 8.

SAUCEPAN-STAND (HALVED OR NOTCHED JOINT).

*Drawing.*—The edge and face views are shown of the two pieces forming the saucepan-stand: draw the pieces in oblique projection, full size.




View of block of wood in oblique projection.




View in orthographic projection, showing how joint is worked.

FIG. 13.—SAUCEPAN-STAND.

## Woodwork.

### MATERIAL REQUIRED.

| Description. | Quantity. | Size. |
|---|---|---|
| Yellow deal ... | 10″ | $1\frac{3}{4}'' \times 1\frac{1}{4}''$ |

### Questions.

1. Write notes about a marking gauge, illustrating the various parts by sketches.

2. What is cubic measure? Give the number of cubic inches contained in Lesson 8 when completed. How much water would it displace if floated? Give your answer in cubic inches and cubic centimetres.

3. Give four instances within your knowledge of the use of this joint in wooden structures.

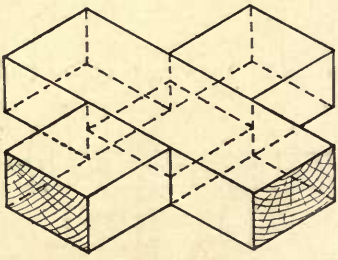


Fig. 14.—Saucepan-Stand.

View in isometric projection, showing joint fixed together.

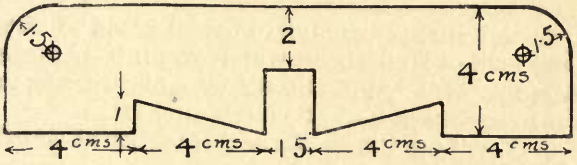
## LESSON 8a.

Draw an equilateral triangle on a piece of wood having its sides 15 cm. Cut this out, and from the same piece of wood cut out a square piece of 8 cm. side. Compare their area by weighing them. Enter results in your notebook.

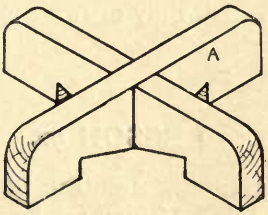
## LESSON 9.

### POT-STAND.

*Drawing.*—An isometric sketch of the pot-stand and an elevation of piece A alone are given.




Face view of piece A.




Isometric view.

FIG. 15.—POT-STAND.

Adopting metric measurements, copy the given elevation, and project its plan; then draw eleva-

tion and plan of the other piece forming the stand.

### Woodwork.

MATERIAL REQUIRED.

| Description. | Quantity. | Sizes. |
|---|---|---|
| Whitewood ... ... | 45 cm. | 6 cm. × 2 cm. |
| Iron flat-headed screw | 1 | 1″ No. 10 |

### Questions.

1. Before commencing to work Lesson 9 measure the block of wood from which you intend to make it, and give the approximate cost of such a piece, if whitewood is sold at 5s. per cubic foot.

2. What are the chief characteristics of the class of trees known as 'leafy timber trees'? Give the names of any such trees, and the names of places you know in which they grow.

## LESSON 9a.

### Wooden Measure, marked in English and Metric Units of Length.

*Drawing.*—Draw full size the equilateral triangle shown above. Assuming this view to be the end of a triangular prism 12″ long, project from the end view the true shape of two of its sides. On one

of these side views set off the English units of length, and on the other the metric units of length.

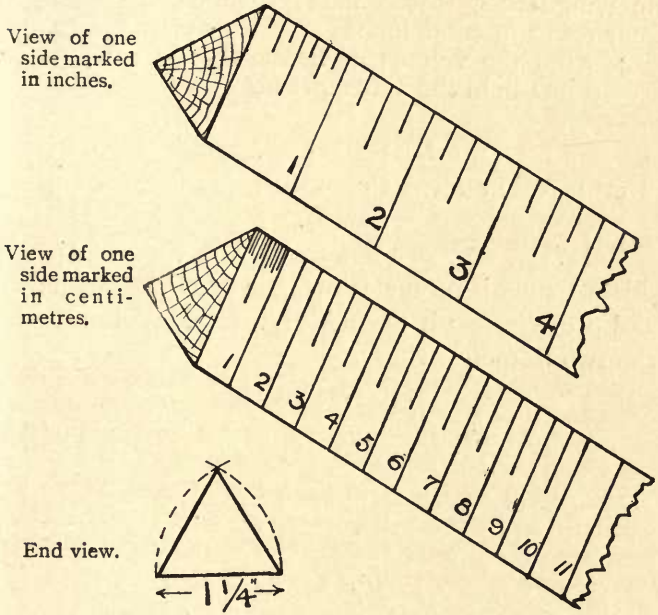



FIG. 16.—WOODEN MEASURES, MARKED IN ENGLISH AND METRIC UNITS OF LENGTH.

## WOODWORK.

### MATERIAL REQUIRED.

| Description. | Quantity. | Size. |
|---|---|---|
| Beech ... ... | 13″ | $1\frac{3}{8}″ \times 1\frac{3}{8}″$ |

### Questions.

1. Find the area of the end of the prism, and, knowing its length, calculate its volume, expressing your result in cubic inches and cubic centimetres.

2. Find the volume of a rectangular box that would just hold the above prism.

## LESSON 10.

### Blind-Roller or Copper-Stick (Octagonal Prism).

*Drawing.*—Draw full size an end view of the prism, which is a regular octagon of $1\frac{1}{4}''$ diameter; and project from it the side elevation. Also draw the two isometric views.

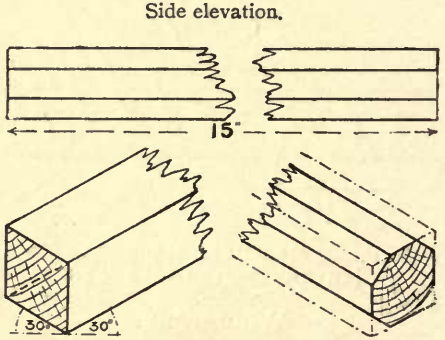



Fig. 17.—Blind-Roller or Copper-Stick (Octagonal Prism).

Isometric views.

*The prism may be used as a washhouse copper-stick, or its length may be altered to make it suitable for a blind-roller.*

## Woodwork.

### MATERIAL REQUIRED.

| Description. | Quantity. | Size. |
|---|---|---|
| White deal ... | 18″ | $1\frac{1}{2}$″ × $1\frac{1}{2}$″ |

## Questions.

1. Describe the wood used for Lesson 10.

2. Explain what you understand by the word 'isometric.' What advantage is gained by using isometric projection in preference to orthographic projection?

## LESSON 10a.

### Vernier.

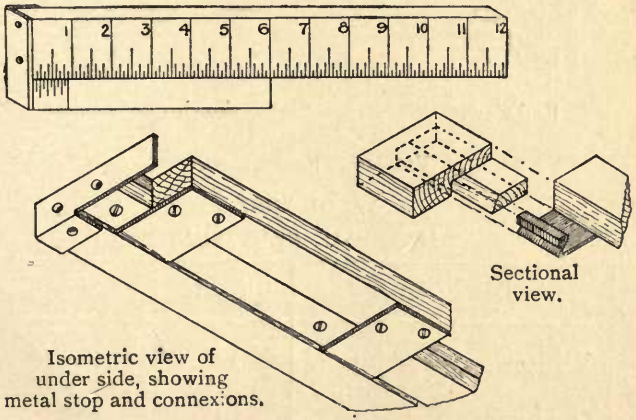

View in oblique projection.
1 2 3 4 5 6 7 8 9 10 11 12
Sectional view.
Isometric view of under side, showing metal stop and connexions.

Fig. 18.—Vernier.

*Drawing.*—Draw an elevation, plan, and free-hand sketches of details.

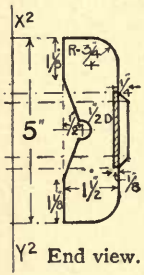
Make a list of materials required.

Any hard close-grained wood may be used; the three pieces of metal may be cut from sheet brass or copper.

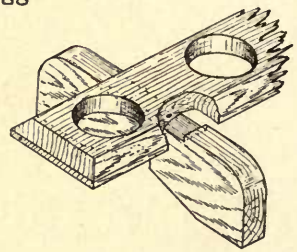
## LESSON 11.

### EGG-STAND.

*Drawing.*—Draw the end view to scale of half the full size, and from it project the plan of an egg-stand to hold six eggs.




End view.



Sketch showing connection of top to foot piece.

FIG. 19.—EGG-STAND.

### WOODWORK.

MATERIAL REQUIRED.

| Description. | Quantity. | Sizes. |
|---|---|---|
| Whitewood (for top)... | 14″ | $2\frac{1}{4}″ \times \frac{1}{2}″$ |
| ,, (for feet) | 12″ | $1\frac{3}{4}″ \times \frac{5}{8}″$ |
| Oval wire nails ... | 4 | 1″ |

The top to be glued and nailed to the feet.

### Questions.

1. Write notes on American whitewood.
2. Give the meaning of the following terms used in connexion with the circle, and illustrate your answers with sketches wherever possible: radius, circumference, diameter, centre, arc, chord, segment. What multiple is the circumference of the diameter?
3. Describe the chisel you have used. What name is given to it to distinguish it from other kinds?

## LESSON 11a.

### TEST-TUBE STAND.

*Drawing.*—Prepare the necessary drawings to make the test-tube stand as illustrated (see p. 26).

Take off from your drawing the quantity of material required, and execute it in basswood.

## LESSON 12.

### Garden Dibber (Tee-Halved Joint).

*Drawing.* — A model like the one illustrated on p. 27 is given to you, worked to metric

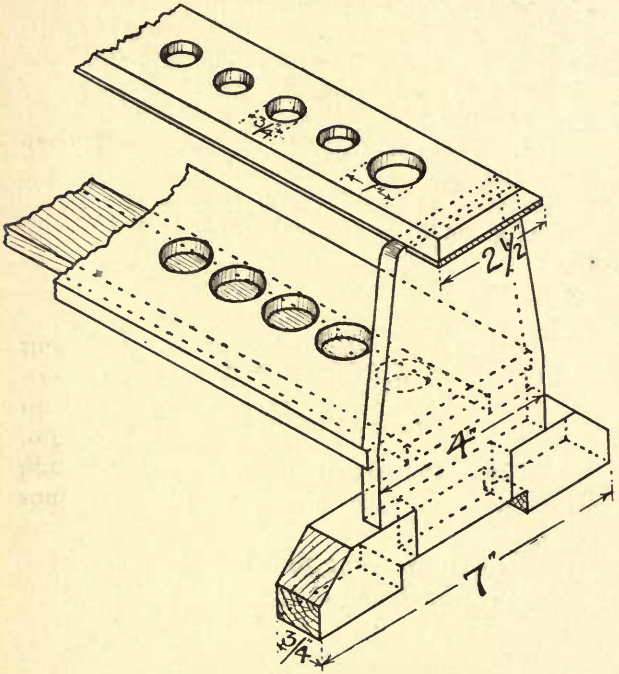



FIG. 20.—TEST-TUBE STAND.
Isometric view of one end.

dimensions. Make a freehand dimensioned sketch of the model, put it away, and from your sketch

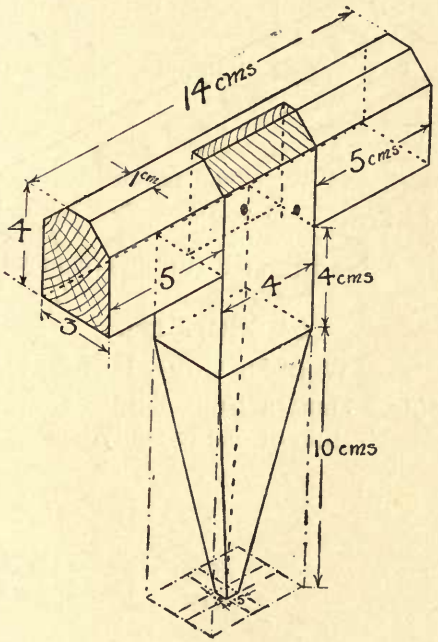



FIG. 21.—GARDEN DIBBER.

draw an elevation and plan of the complete model and an oblique view of the shorter piece, using metric measurements.

### Woodwork.

MATERIAL REQUIRED.

| Description. | Quantity. | Size. |
|---|---|---|
| Yellow deal ... | 34 cms. | 5 × 4 cms. |

Questions.

1. Sketch and describe a tenon-saw.
2. Give any instance where you know the tee-halved joint has been used.
3. Determine the area (in square feet) of your bench top.

## LESSON 12a.

### Wooden Compasses.

*Drawing.*—Make a front elevation, a plan, and an inside elevation of one leg only.

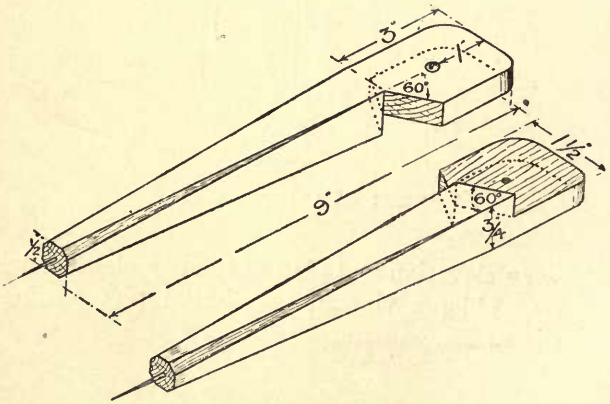



Fig. 22.—Wooden Compasses.

*Benchwork.*—Make the model from a moderately hard wood. Strong needles may be inserted for the points, and the pivot may be either a screw or a fine bolt with wing-nut.

## LESSON 13.

### Hat and Coat Peg.

*Drawing.*—Copy the front and side views shown, and give a plan of piece A alone.

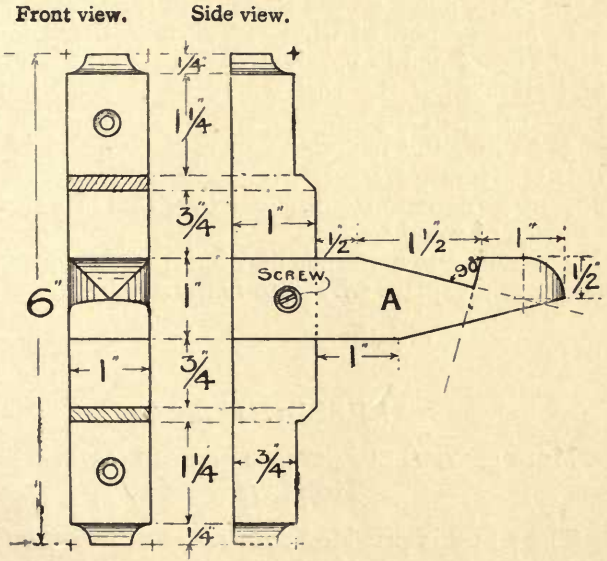



Fig. 23.—Coat-Peg.

### Woodwork.

MATERIAL REQUIRED.

| Description. | Quantity. | Sizes. |
|---|---|---|
| Satin walnut ... ... | $12\frac{1}{2}''$ | $1\frac{1}{8}'' \times 1\frac{1}{8}''$ |
| Flat-headed brass screw | 1 | $\frac{3}{4}''$ No. 10 |

### Questions.

1. Write notes on the wood used for Lesson 13.
2. Make a note of what you surmise the weight of the coat-hook to be. Verify by using the scales, and state what the cost would be to send it to Exeter by parcel post.
3. Sketch the hammer you use. Explain how it is one form of lever. What is the mechanical advantage derived from its use over that of a stone or piece of wood?
4. Name the materials of which the hammer is made, and explain why such materials are used.

## LESSON 13a.

### Model to illustrate the Principle of Moments.

The wheel is provided with series of holes, each series being at equal distances from the centre.

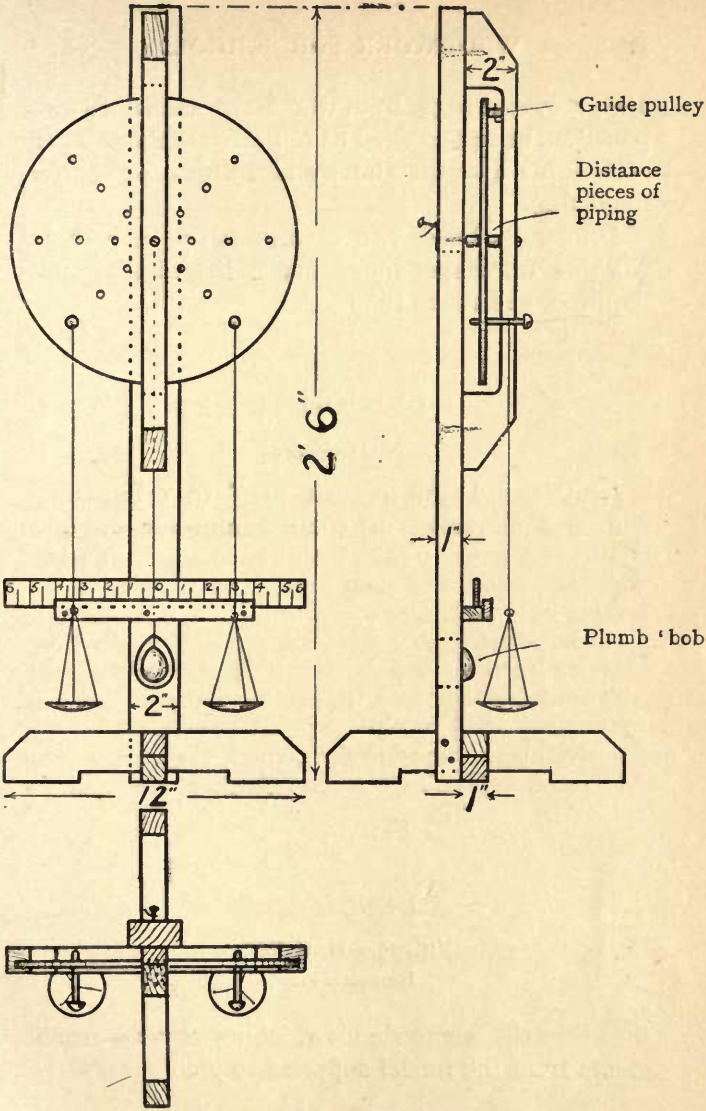



FIG. 24.—MOMENTS APPARATUS.

Two movable pegs, from which are suspended two pans, can be so arranged as to illustrate the relation of weights and distances and turning power (or moments).

*Drawing.*—Draw two elevations and a plan as working drawings, make out a list of materials required, and make the model.

## LESSON 14.

### Nail-Box.

*Drawing.*—Draw to scale of 6″ to 1 foot plan and end elevation of such a nail-box as that

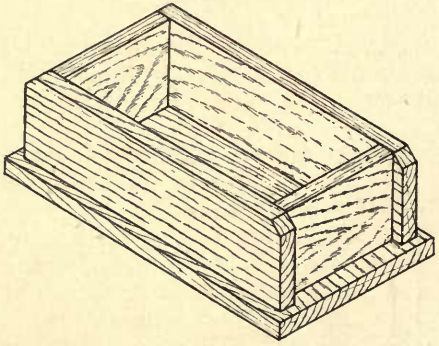


Fig. 25.—Nail-Box.
Isometric view.

shown in the isometric view, taking your measurements from the model supplied to you.

## Woodwork.

### MATERIAL REQUIRED.

| Description. | Quantity. | Sizes. |
|---|---|---|
| White deal ... ... | 2′ | $2\frac{1}{4}'' \times \frac{5}{8}''$ |
| „ „ ... ... | 10″ | $5'' \times \frac{5}{8}''$ |
| Oval wire nails ... | 2 dozen | $1\frac{1}{4}''$ |

## Questions.

1. Sketch and describe the different kinds of nails with which you are familiar. What is rust, and how can nails be prevented from rusting?

2. Describe the pincers. Show by a sketch how you would extract a nail with their aid, but with the least exertion on your part.

3. Show that pincers behave as a compound lever, and explain which are the fulcrum, the weight, and the power when they are in use. Give other examples of compound levers.

4. A pound of $1\frac{1}{4}''$ oval wire nails costs 3d. What would the nails cost in making a score of such boxes as in Lesson 14?

5. Give the cubical capacity of the box you have made. What would it cost to line it with lead at 5d. per square foot?

## LESSON 14a.

### Model to illustrate the Relative Positions of Power, Weight, and Fulcrum in the Three Kinds of Levers.

*Drawing.*—Prepare the necessary working drawings and list of materials required before making the model.

The pulley is of the kind used for Venetian

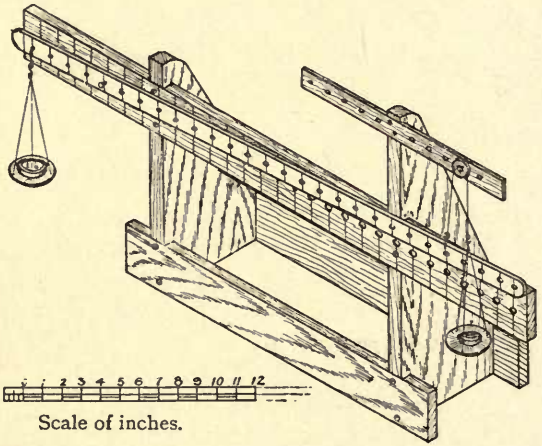



Fig. 26.—Lever Apparatus.
View in isometric projection.

blinds, a large picture nail acts as fulcrum, and the pans may be made from canister lids such as are used for boot polishes. The two long bars have holes pierced 1″ centre to centre for the picture-nail to enter.

## LESSON 15.

### WATCH-STAND.

*Drawing.*—Draw full size the two views as shown.

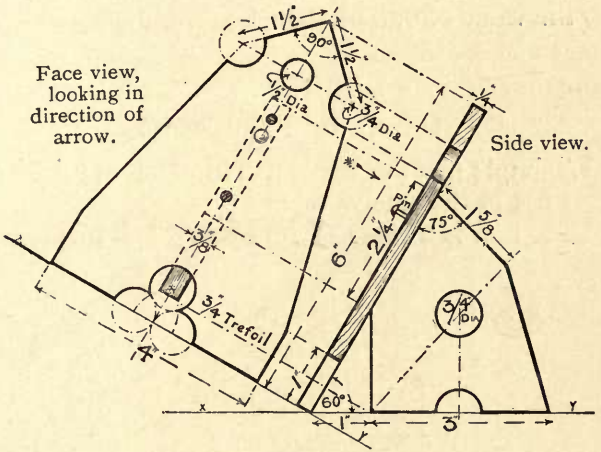



FIG. 27.—WATCH-STAND.

### WOODWORK.

MATERIAL REQUIRED.

| Description. | Quantity. | Sizes. |
|---|---|---|
| Virginian red cedar ... | 7″ | $4\frac{1}{2}$″ × $\frac{3}{8}$″ |
| ,, ,, ... | 5″ | $3\frac{1}{4}$″ × $\frac{1}{2}$″ |
| Iron flat-headed screws | 2 | $\frac{3}{4}$″ No. 6 |
| Brass escutcheon pin | 1 | 1″ or $\frac{3}{4}$″ |

### Questions.

1. Write notes on Virginian red cedar.

2. Pack the watch-stand in a parcel, direct it to an imaginary person in Paris, and find the cost of postage in English and French money. What is the value of one franc in English money?

## LESSON 15a.

### Model of Steelyard.

A simple piece of apparatus illustrating principle and use of the steelyard.

The arm is a piece of thin pearwood, pivoted to

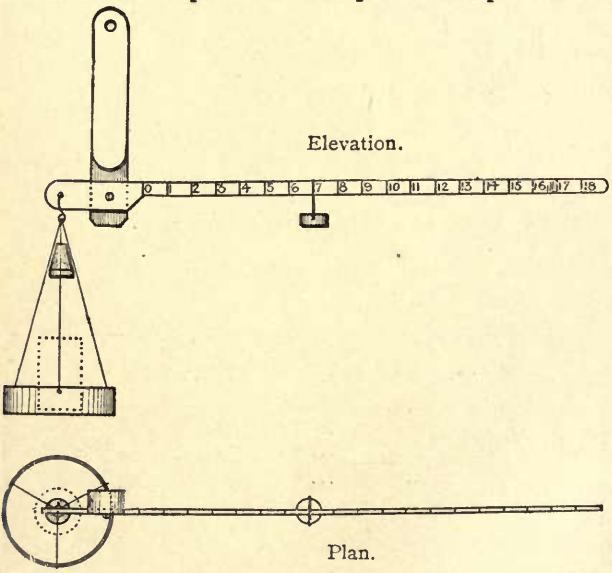



Fig. 28.—Steelyard.

another piece of wood by means of a round-headed screw, which acts as the fulcrum; the pan suspended from the shorter arm is a canister lid, which contains the body the weight of which is to be found; a piece of lead is suspended above the pan to keep the lever in equilibrium; the constant weight suspended from the long arm is a piece of lead with a wire loop, which can be moved along the graduated arm.

## LESSON 16.

### TOOTH-BRUSH RACK.

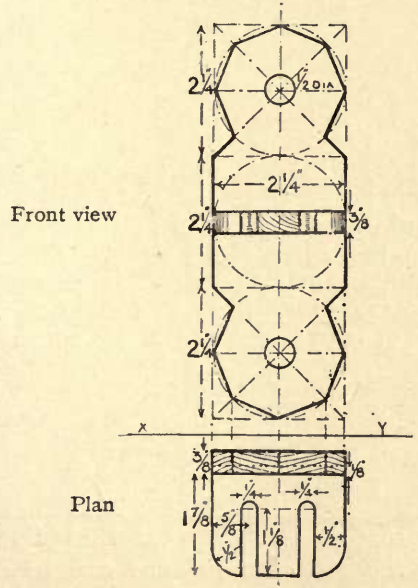



FIG. 29.—TOOTH-BRUSH RACK.

*Drawing.*—Draw full size the views shown, and add a side elevation. The top and bottom in the front elevation are parts of regular octagons. The shelf is housed into the back $\frac{1}{8}''$.

### Woodwork.

MATERIAL REQUIRED.

| Description. | Quantity. | Sizes. |
|---|---|---|
| Mahogany ... ... | 10″ | $2\frac{1}{2}'' \times \frac{1}{2}''$ |
| Iron flat-headed screws | 2 | $\frac{5}{8}''$ or $\frac{3}{4}''$ No. 6 |

### Questions.

1. Sketch any screws with which you are familiar, and say what you know about them.
2. What are polygons? Illustrate your answer by sketches of different kinds of polygons.
3. Measure the angles of the polygon made, and prove by geometry that your result is correct.
4. Give notes on mahogany, and mention a few useful pieces of furniture made of this wood.

## LESSON 16a.

### A Simple Balance.

The construction is such that the principles involved in the use of a balance can be easily

demonstrated. The pans can be replaced by simple pill-boxes.

*Drawing.*—Give a view of the balance in isometric projection, and a freehand sketch of the joint used to unite the base and pillar.

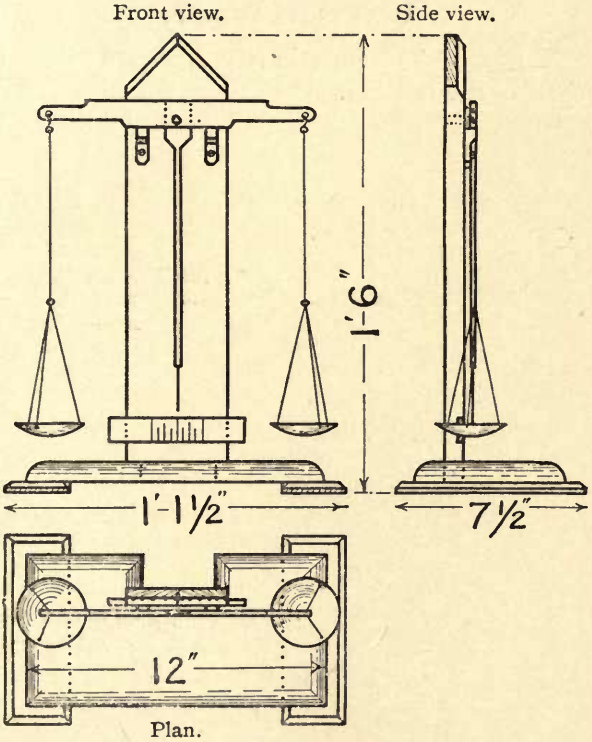



FIG. 30.—SIMPLE BALANCE.

The pivot is a piece of three-corner file, encircled by a piece of brass tubing in the beam only.

*Woodwork.*—Work the balance in mahogany and basswood.

## LESSON 17.

### WALL-BRACKET.

*Drawing.*—An isometric view is shown of a plain model of the bracket.

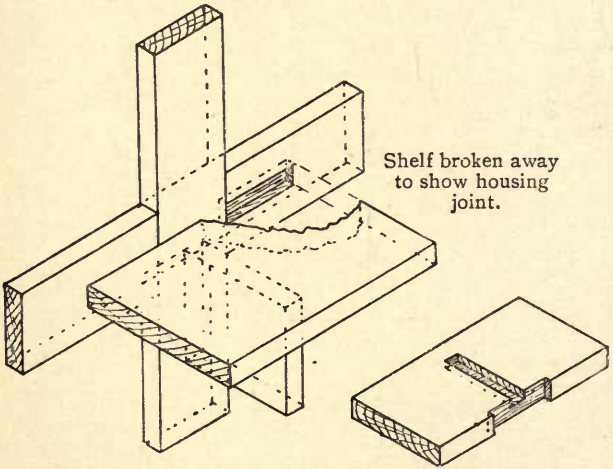



FIG. 31.—WALL-BRACKET.
Isometric view of plain model.

A model will be lent to you, from which you are required to make rough freehand dimensioned

sketches of such views as you consider will be necessary for working drawings. The bracket must not exceed the following dimensions:

| | |
|---|---|
| Height ... ... ... ... | 15″. |
| Width ... ... ... ... | 15″. |
| Depth from back to front edge of shelf ... ... ... ... | 8″. |
| Thickness of material ... ... | ½″. |

From your rough sketches prepare correct working drawings, altering the form to be pleasing to the eye without interfering with the principles of construction.

### Woodwork.

Prepare a list of material required, and make the bracket in satin walnut.

### Questions.

1. If twenty boys are to make brackets similar to yours, state how much timber will be required, and its probable cost at the rate of 3½d. per foot super.
2. Explain the following terms in connexion with timber: 'knots,' 'sapwood,' 'shakes,' 'waney edge,' 'warping,' 'medullary rays.'

## LESSON 17a.

### A Barometer.

The model consists of an upright piece of board. housed into a hexagonal base, with an angle block glued at the back.

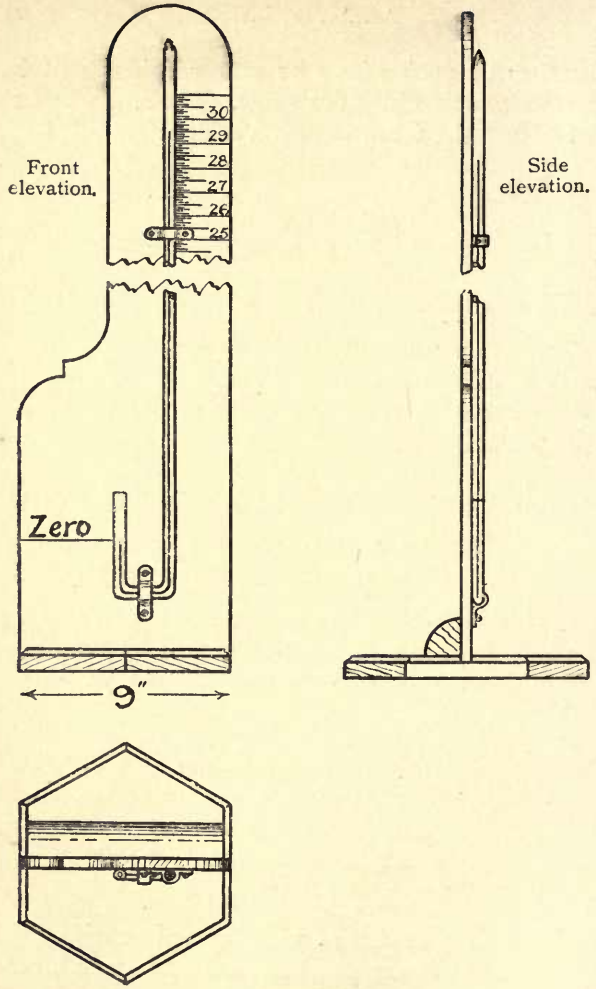



FIG. 32.—A BAROMETER.

*Drawing.*—Draw plan and elevation of the stand.

*Woodwork.*—Work the stand as shown by your drawing.

## LESSON 18.

### MARBLE-BOARD.

Construct a scale of two-thirds (that is, 8″ to represent 12″) at the bottom of your paper. Using

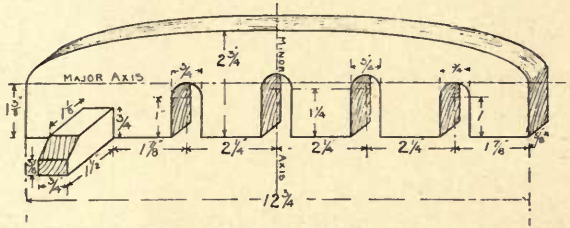



FIG. 33.—MARBLE-BOARD.
View in oblique projection.

this scale, draw an elevation and plan. The top of the board is semi-elliptical in shape. Make an isometric view of the foot-piece.

### WOODWORK.

MATERIAL REQUIRED.

| Description. | Quantity. | Sizes. |
|---|---|---|
| Kauri pine ... ... | 13″ | $3\frac{1}{2}'' \times \frac{3}{4}''$ |
| ,, ,, ... ... | 5″ | $\frac{7}{8}'' \times \frac{7}{8}''$ |
| Oval wire nails ... | 2 | $1\frac{1}{4}''$ |

### Questions.

1. Describe the kauri pine.
2. Give sketches of and notes on the brace and bits.
3. State any mechanical advantage gained when using the brace and bit.
4. Draw an ellipse, and find its area.

## LESSON 18a.

### Bridge for Specific Gravity Experiments, to be used in Conjunction with the Balance.

*Drawing.*—A plan and end view are shown. Give a view in some form of conventional perspective,

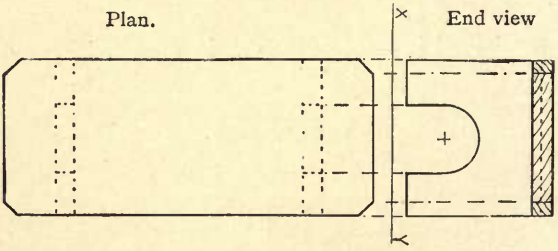



Fig. 34.—Bridge for Specific Gravity Experiments.

the sizes to be suitable to the balance to be used.

*Woodwork.*—Execute in any suitable wood.

## LESSON 19.

### BENCH-HOOK.

*Drawing.*—Convert the given oblique view into an isometric view. Scale, 6 inches to 1 foot.

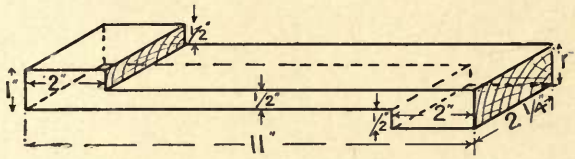



FIG. 35.—BENCH-HOOK.
View in oblique projection.

### WOODWORK.

MATERIAL REQUIRED.

| Description. | Quantity. | Size. |
|---|---|---|
| Yellow deal ... | 12″ | $2\frac{1}{2}$″ × $1\frac{3}{4}$″ |

### QUESTIONS.

1. Make a sketch and write a brief description of a handsaw. What is the 'set'?

2. In what position would you place the cutting edge of the bradawl when commencing to bore a hole, and what becomes of the wood displaced by the bradawl?

## LESSON 19a.

### A Stand for Pulleys.

The top rests are provided with simple picture-hooks to carry the sheaves, and these blocks can be moved along horizontally.

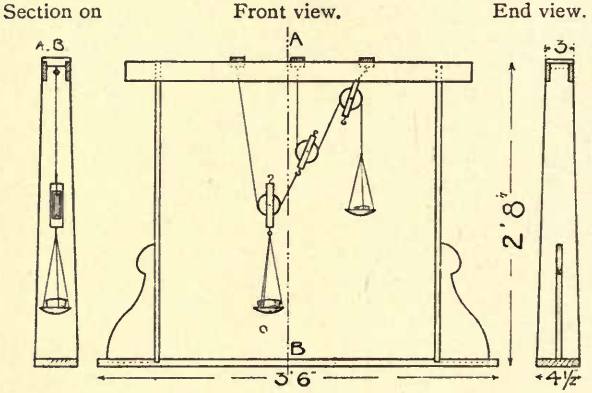



Fig. 36.—A Stand for Pulleys.

## LESSON 20.

### Original Model.

*Drawing.*—Prepare working drawings of a model of your own design, embodying tool operations similar to those you have practised in the previous lessons. State the kind of material in which you propose to execute the design, and write a list showing the sizes required.

*Woodwork.*—On the drawing being approved, work the model.

QUESTIONS.

1. Give a general description of your design and model, and state from the experience gained while making it what improvements you would suggest.

## LESSON 20a.

ORIGINAL SCIENTIFIC MODEL.

Prepare working drawings of and make an original scientific model, which may be in the form of a toy, useful article, or simple apparatus, utilizing some scientific principle, such as the lever.

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# WOODWORK FOR SCHOOLS

## PART II

### LESSON 21.

OXFORD FRAME.

*DRAWING.*—Draw the given elevation to scale of three-quarters the full size, and show a section on

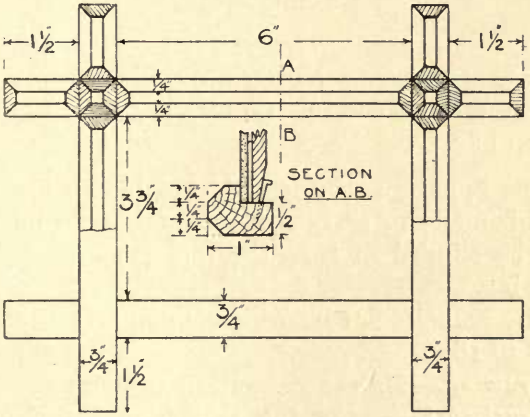



FIG. 37.—OXFORD PICTURE-FRAME.

the line AB full size. (The chamfers need only be drawn at and around one joint.) Make a perspective hand sketch to show the joint used.

*Benchwork.*—Material suggested: black walnut for frame, yellow pine for back, 21 oz. glass.

*N.B.—In this and all future exercises you are to measure from your drawing the quantities and sizes of the materials required, and write them down in the form given for the exercises in Part I.*

QUESTIONS.

1. Write notes upon walnut-trees and their products.
2. Briefly describe window-glass.

## LESSON 21a.

ANGLE MIRRORS WITH DIVIDED CIRCLE, TO DETERMINE THE NUMBER OF IMAGES FORMED WHEN MIRRORS ARE INCLINED AT DIFFERENT ANGLES.

The apparatus consists of two folding grooved boards made to carry two mirrors. The mirrors can be slipped in from the top, as shown in the drawing.

The semicircular board is marked off in degrees —0° to 180°.

*Drawing.*—Make an elevation and plan.

*Benchwork.*—Make the two frames and base-board in any suitable material. Screw one frame to the base, and fasten the two frames together with a large butt hinge.

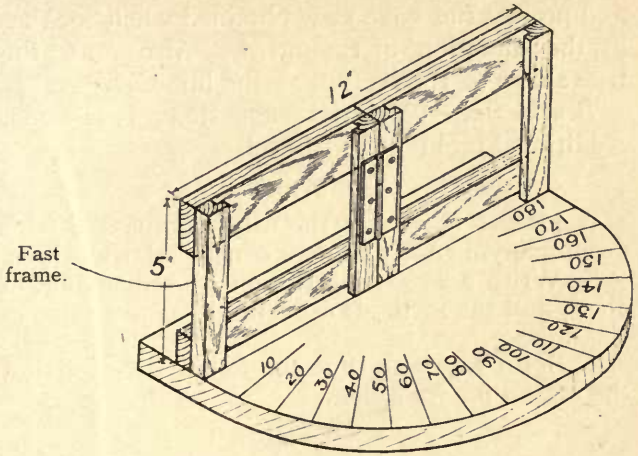



FIG. 38.

## LESSON 22.

### OBLIQUE SAWING AND CHISELLING.

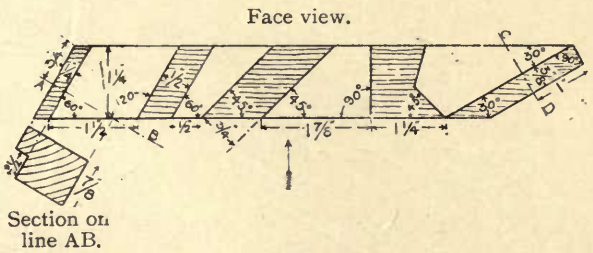



FIG. 39.—OBLIQUE SAWING AND CHISELLING.

*Drawing.*—A face view and a section on the line AB are shown. Draw the face view, describing the angles with the pencil compasses,

and project the edge view obtained when looking in the direction of the arrow. Also draw the true shape of the section on the line CD.

*Benchwork.* — Material suggested: bass-wood. Additional tool required, bevel.

### Questions.

1. Make a sketch of the wing compasses, with accompanying notes on their construction and uses.
2. Write a brief description of the felling of trees, and the methods used in the conveyance of the logs.
3. State the best time for felling trees, giving the reason for your answer.

## LESSON 22a.

### A Simple Optical Bench.

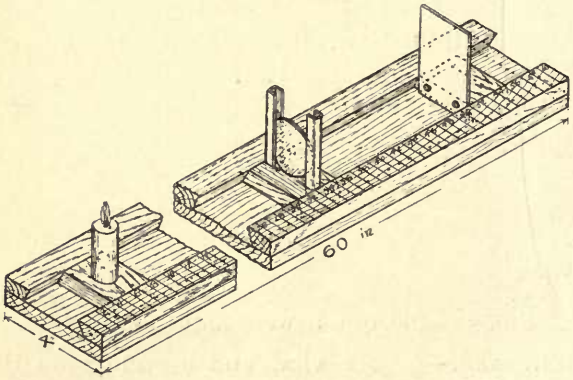



Fig. 40.

The bench is grooved to carry the movable supports for the candle, screen, and lens. The

lens carriage is made of grooved metal strips, and is so arranged that lenses of different diameters can be fitted into it. The bench is graduated, so that when a clear image is obtained on the screen, the position of the candle, lens, and screen can be accurately read off.

Prepare the necessary working drawings and execute the bench.

## LESSON 23.

### MATCH-BOX BRACKET.

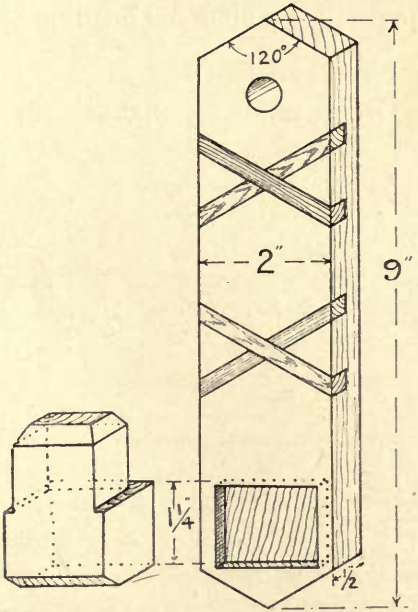



FIG. 41.—MATCH-BOX BRACKET.
View in oblique projection.

*Drawing.*—Oblique views are shown of the two pieces which together form the Bracket. Draw front and side elevations of the Bracket, full size, and make a hand sketch of piece A.

*Benchwork.*—The choice of woods is left to you; aim at securing a pleasing effect by their combination.

### Questions.

1. Describe the materials used for Lesson 23.
2. Describe the different kinds of oilstones. What kind of oil would you use? Why do you prefer the particular kind you mention?

## LESSON 23a.

### Oscillating Magnetometer.

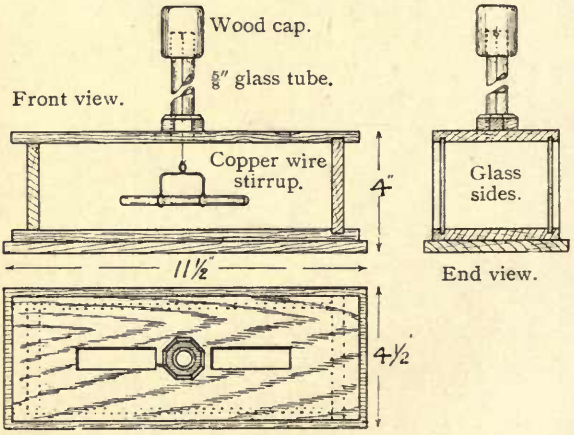



Fig. 42.

The top, bottom, and ends of the box are of wood. Rectangular pieces of glass, sliding in grooves, form the front and back, and on the bottom of the box is glued a rectangular mirror; the top of the glass tube is fitted with a cap, to which is attached a small hook, and from this is suspended a stirrup of bent copper wire, carrying the oscillating magnet whose times of oscillation are required.

*Drawing.*—Prepare working drawings in either orthographic or isometric projection.

*Benchwork.*—Make the box in some suitable material.

## LESSON 24.

### KEY-RACK.

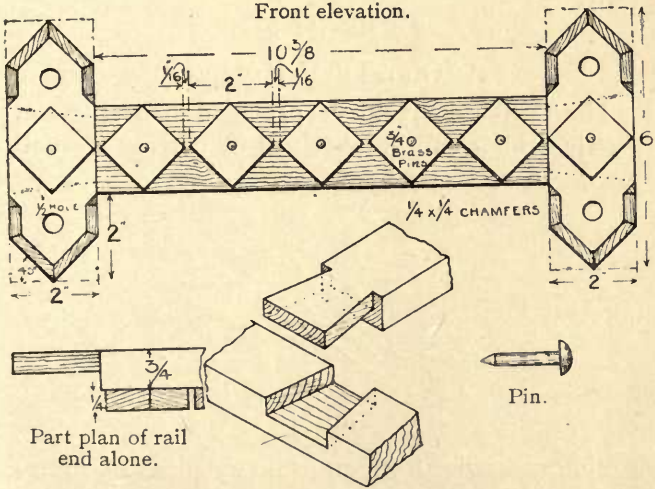



FIG. 43.—KEY-RACK.

*Drawing.*—Construct a scale of two-thirds. To this scale copy the front elevation of the Key-Rack and project its plan.

Make a freehand sketch of the joint used to connect the pieces together.

*Benchwork.*—Materials suggested: black walnut, and 1″ brass escutcheon pins for keys, button-hooks, scissors, etc., to hang upon.

### Questions.

1. Sketch and describe the bevel.
2. Describe briefly the conversion of timber and its seasoning.
3. A chisel has a corner snapped off; how would you restore it to working order?

## LESSON 24a.

### A Test-Tube Holder.

The Test-Tube Holder is provided with a piece of elastic, which can be obtained by cutting a small

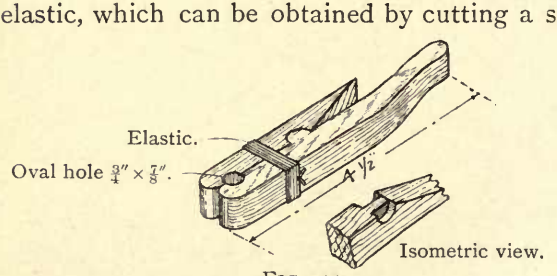



Fig. 44.

section crosswise from an ordinary piece of india-rubber tubing attached to Bunsen burner.

*Drawing.*—Make a dimensioned freehand sketch suitable to work from.

*Benchwork.*—Material suggested: white-wood.

## LESSON 25.

### BOOK-STAND.

*Drawing.*—The illustration shows a plain model of a Book-Stand in oblique projection. Prepare working drawings to a convenient scale,

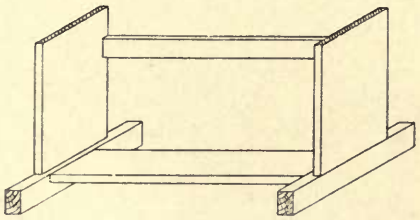


FIG. 45.—BOOK-STAND.
View in oblique projection of plain model.

showing how you intend jointing the pieces together, and completing the design in an artistic manner. You are not to exceed the following sizes:

| | |
|---|---|
| Length ... ... ... ... | 18″ |
| Height ... ... ... ... | 12″ |
| Length of foot-pieces ... ... | 9″ |

*Benchwork.*—Material suggested: mahogany.

### QUESTIONS.

1. Describe some of the common faults met with in timber.

2. Keep a record of the time taken in making the Book-Stand. If you were paid at the rate of 8d. per hour, what would be the cost of labour involved in making the Stand?

## LESSON 25a.

### The Inclined Plane.

The plane is made of two long pieces of glass tubing, with copper wire bent round to connect them with smaller pieces of tubing, placed at the

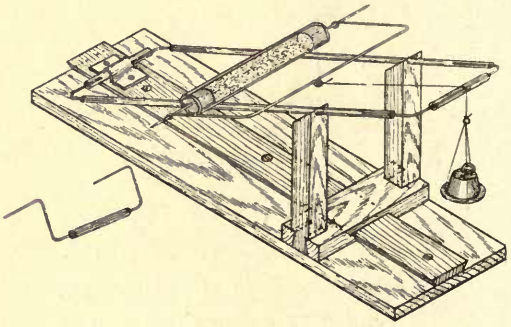


Fig. 46.

top and bottom. The roller is a piece of combustion tubing, filled with sand and corked at the ends. A knitting-needle passes through from end to end. Copper wire is bent round the needle at each end, and to the middle of this wire is attached a string, to which the scale-pan is suspended. The whole plane is fixed, as shown in the drawing, to a base-board provided with movable and

sliding supports for the variation of the angle of the plane.

The plane can be used for horizontal forces, by replacing the top piece of wire and tube with the bent piece seen detached.

*Drawing.*—Make the necessary working drawings.

*Benchwork.*—Material suggested: yellow deal, yellow pine, or white-wood, $\frac{1}{2}$″ and 1″ glass tubing, copper wire, copper or brass staple.

## LESSON 26.

### TRUING-STICK OR WINDING-LATH.

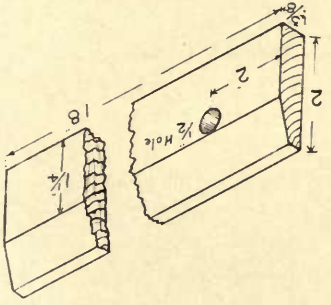



FIG. 47.—TRUING-STICK.

View in isometric projection.

*Drawing.*—An isometric view is shown of a Truing-Stick. Make a dimensioned hand sketch of the Stick suitable to work from.

*Benchwork.*—Material suggested: mahogany.

### Questions.

1. Describe how you secured a perfectly straight edge on the Truing-Stick, and illustrate your description with sketches.
2. The sharpening bevel of a plane iron has worn down. State what you would do to restore it to perfect working order.
3. What is meant by warping and twisting?

## LESSON 26a.

### Simple Galvanoscope or Current Indicator.

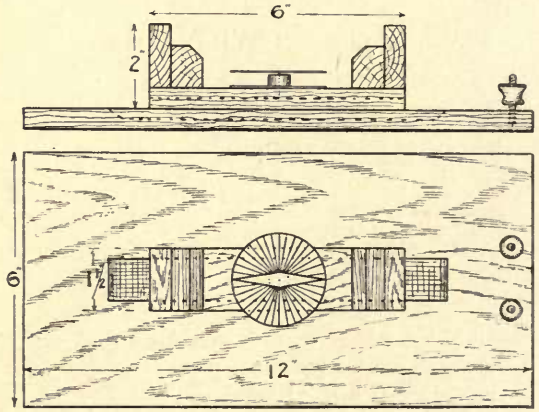



Fig. 48.—Simple Galvanoscope or Current Indicator.

This apparatus consists of a wooden framework, with sides supported by glued blocks. A groove about 1″ wide is cut underneath the bottom to

allow silk-covered wire (which is wound round the frame ten or twelve times) to lie evenly.

The frame is fastened to a wooden base, having first had a groove cut in it similar to the one in the bottom of the frame. The ends of the wires are attached to two binding screws.

A graduated paper scale is glued to the bottom, care being taken that the zero of the scale is under the middle wire.

Fix a sewing-needle vertically in a small cork so that the point projects about $\frac{1}{4}''$, and then glue the cork so that the needle forms a pivot at the centre of the card.

Place a magnetic needle about 2″ long on the pivot.

*Drawing.*—Make a working sketch of the model and prepare the paper scale.

*Benchwork.*—(See description above.) Material suggested: mahogany.

## LESSON 27.

### TEE-SQUARE.

*Drawing.*—A plan and elevation are shown of the Tee-Square. Draw a view in isometric projection, but altering the dimensions to their nearest equivalent in the Metric System.

*Benchwork.*—Material suggested: pear-wood or mahogany, brass screws and glue.

### QUESTIONS.

1. Trace the sides of the Tee-Square, AB and

BC, measure to scale, draw a line connecting A and C, measure the line AC, and find if the square on AB plus the square on BC equal the square on AC. If so, the angle ABC is a right

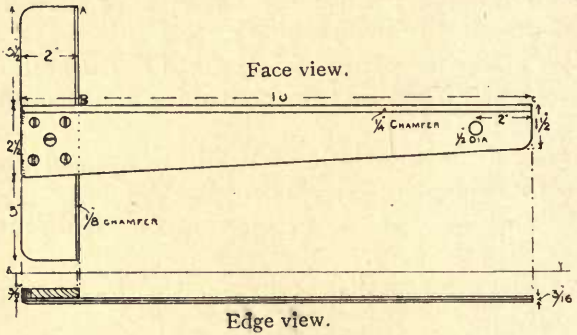



FIG. 49.—TEE-SQUARE.

angle, and your Tee-Square is exact; if not, by the aid of a protractor measure its error.

2. Describe the materials used for the Tee-Square.

3. Describe the chief points of difference between cone-bearing and leafy timber trees.

## LESSON 27a.

### A BURETTE STAND.

The drawing shows the chief parts necessary in the construction. An ordinary hinge is screwed at the back of the carrier to allow the burette to be fixed in position. Ordinary sash thumb-screws are used to clamp the movable piece to the

wooden support, and to keep the burette in the grooved pieces or arms. The space for the burette is lined with cork, to prevent cracking if a little extra pressure is given to the screw.

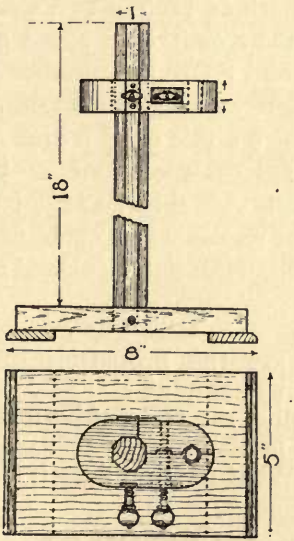



FIG. 50.—BURETTE STAND.

*Drawing.*—Make an elevation and plan full size.

*Benchwork.*—Material suggested: any moderately hard wood. The hole nearest the head of the left-hand thumb-screw must be elongated horizontally, to allow the hinged arm to move easily.

## LESSON 28.

*Drawing.*—1. Construct a triangle having a base $4\frac{1}{2}''$ long, and the angles at the base 90° and 60° respectively.

2. The length of each of two sides of a triangle is $4\frac{1}{2}''$, and their contained angle 90°. Complete the triangle and figure the number of degrees contained in the remaining two angles.

3. Describe a circle of $\frac{1}{4}''$ radius in the centre of both triangles; draw edge views of both triangles, making them $\frac{3}{16}''$ thick, and give each a title descriptive of its use when made in wood.

*Benchwork.*—Material suggested: pear-wood.

### QUESTIONS.

1. What are the properties of the triangles mentioned in Lesson 28?

2. Determine the areas of both triangles.

3. What is the hypotenuse of a right-angled triangle? What relation does it bear to the other two sides?

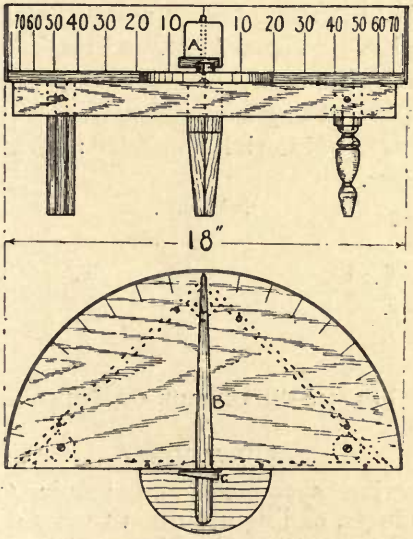
## LESSON 28a.

### APPARATUS TO SHOW THE LAWS OF REFLECTION OF LIGHT FROM PLANE MIRRORS.

A piece of blackened cardboard or thin wood, on which white numbers (representing angles in degrees) are painted, is bent round a semicircular base-board. In the centre of the cardboard a slit is made, to allow rays of light to enter from a candle or lamp placed at the back. A small

toy mirror, C, is fixed to the movable wooden indicator, B.

*Drawing.*—Prepare elevation and plan, and where a turning lathe is provided, prepare a full-size design of one leg.




Elevation.

Plan.

FIG. 51.

*Benchwork.*—Make the base-board and triangular framing in white-wood. If wood is used for index-board, it should be of ash or other pliable timber, and should be steamed before being bent.

Make the legs out of beech, and, if no lathe is available, make them octagonal or square and tapered in section.

## LESSON 29.

### Soap-Tray.

*Drawing.*—Determine the dimensions of a block of soap, and prepare working drawings of a Soap-Dish to hold it, using Metric measurements. The dish is to have an open front, and the bottom is to be grooved with a gouge and sloped towards the back, to prevent any accumulation of water.

*Benchwork.*—Material suggested: sycamore and brass screws.

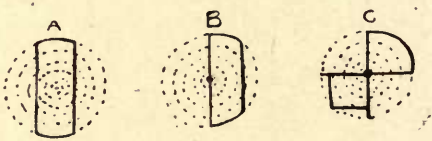



Fig. 52.—Shrinkage of Timber.

### Questions.

1. Describe sycamore and maple trees and their products, calling attention to any differences between the two trees of which you are aware.

2. Say what you know of the different kinds of gouges with which you are acquainted.

3. Three tree-trunks are suggested in section by the dotted lines in the sketches A, B and C (Fig. 52). The heavy lines indicate the shape of some timber cut from the trees. Show by sketches the effect of shrinkage on these pieces, and give reasons to account for the change of shape which would take place in each case.

## LESSON 29a.

BOX TO CARRY LEYDEN JAR BATTERY OF FOUR.

The bottom of the box is lined with tinfoil, and a thin strip is placed up the side to touch the inner points of the metal handle, which is screwed

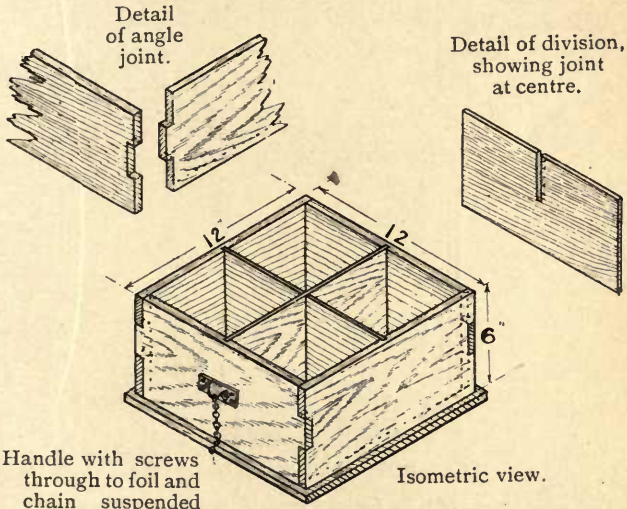



FIG. 53.—BOX FOR LEYDEN JARS.

on from the outside. A chain is fixed to the handle of such a length as to allow it to touch the bench when the box is placed in position.

*Drawing.*—Prepare elevations and plan to scale of half full size, and make freehand sketches of the joints to be used.

*Benchwork.*—Make the box in any suitable

material, gluing the joints together and securing the bottom on to the sides with screws.

## LESSON 29b.

### Collar-Box.

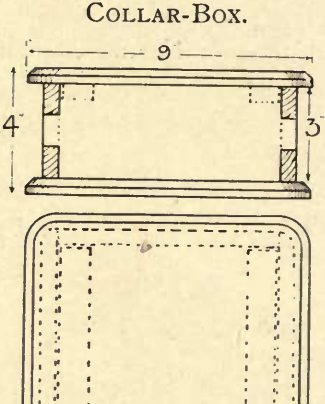



Fig. 54.—Collar-Box, Handkerchief-Box, Tie-Box.

Top may be carved, or designs may be applied in Brushwork, in Gesso, or Repoussé.
For details of angle joints, see Lesson 29a.

Boxes for other purposes—to contain ties, handkerchiefs, jewels, etc.—may be substituted for the collar-box.

The lid and sides of the box offer opportunities for the application of decorative design by means of Brushwork, Gesso, Repoussé, or Carving.

*Drawing.*—Make an isometric drawing of the box you have chosen to make. Show freehand

sketches of the corner joints. The lid is not hinged, but is kept in place by two ledges nailed or screwed to it.

*Benchwork.*—The kind of material to be used should be that which is best adapted to whatever decorative treatment is decided upon.

White-wood and bass-wood are suitable for Brushwork and Gesso; white-wood, oak, kauri, walnut, etc., for Carving.

## LESSON 30.

### NET-PEG.

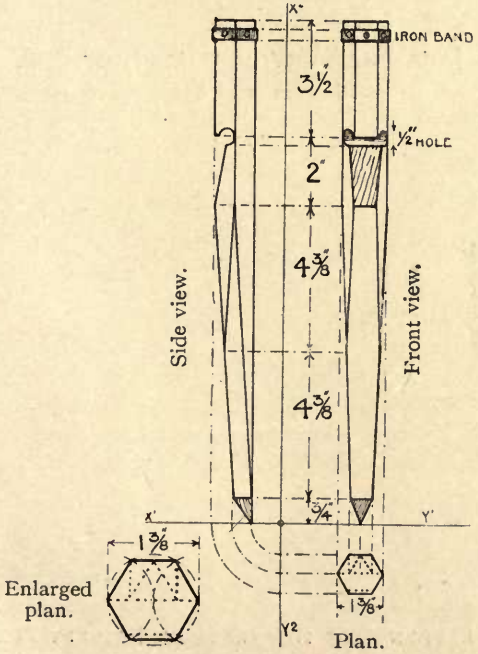



FIG. 55.—NET-PEG.

*Drawing.*—Draw the plan first, then project the two elevations from it. Scale, half size.

*Benchwork.*—Material suggested: beech, strip-iron, and flat-headed nails.

The $\frac{1}{2}$" hole should be bored before working the hexagonal prism.

QUESTIONS.

1. Say what you know of the beech.
2. What is the object of the iron band on the net-peg? Make a drawing in your notebook to determine the length of the band of iron required to go round the top of the peg.

## LESSON 30a.

LEYDEN JARS FOR PREVIOUS BATTERY-BOX.

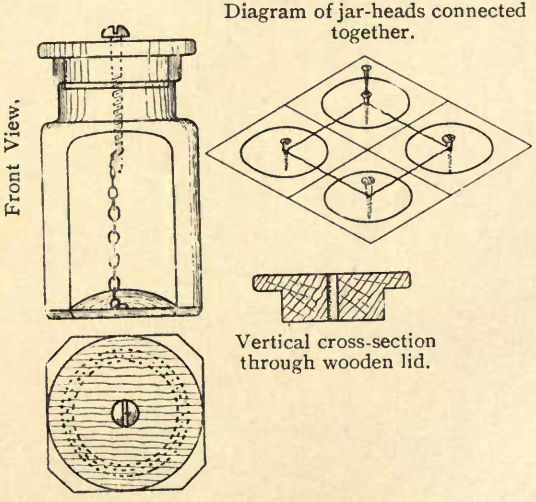



FIG. 56.—LEYDEN JARS FOR PREVIOUS BATTERY-BOX.

*Drawing.*—Make freehand sketches to illustrate what is required for this lesson.

*Benchwork.*—Take four ordinary glass pickle-jars; line the sides and bottom inside and out with tinfoil. The sides are lined to within 2″ of the top of the jar.

Make a wooden circular top to fit each jar. Through this screw a long screw with large head, and attach a metal chain to the lower end, of such a length that it touches the bottom of the jar.

Place the jars in position in the box, and connect the screws by means of copper wire.

## LESSON 31.

### DESK RULER.

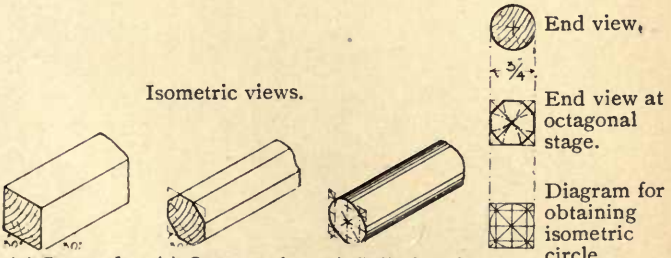



FIG. 57.—DESK RULER.

*Drawing.*—Draw the end elevation shown, and project from it a side elevation 14″ long. The three isometric views show the three stages of manufacture. Copy these three views full size.

*Benchwork.* — Material suggested: American black walnut.

### Questions.

1. Determine the area of the end of the ruler.
2. Find the volume of the ruler.
3. Prepare a piece of paper to cover the curved surface of the cylinder without overlapping. What geometrical figure does the paper now represent? Find its area, and from your observations give a formula which represents the area of the curved surface of the cylinder.

## LESSON 31a.

### A Pipette Stand.

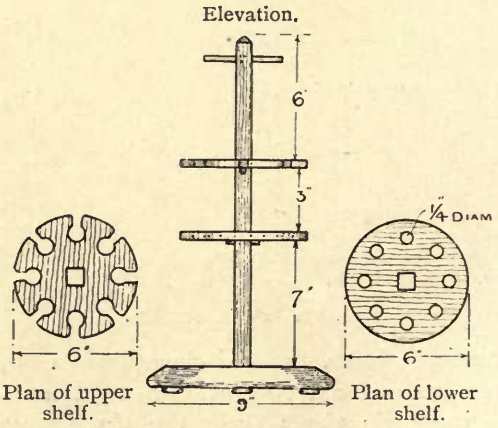



Fig. 58.—A Pipette Stand.

*Drawing.*—Draw the three views shown, and project a complete plan from the elevation.

*Benchwork.*—Material suggested: stem and base of white wood, shelves of mahogany.

The stem to be mortised, and fox-wedged into base.

The shelves are supported by cylindrical pegs.

## LESSON 31b.

### MALLET.

*Drawing.*—Prepare a plan, an elevation, and a section to explain the joint of the mallet.

*Benchwork.*—Material suggested: beech or ash.

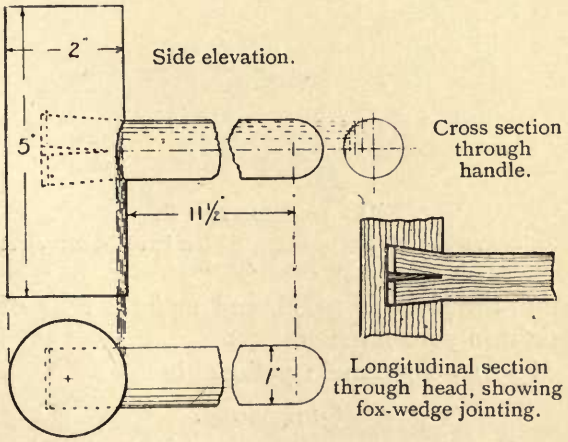



FIG. 59.—MALLET.

## LESSON 32.

### LETTER E.

*Drawing.*—Make full detailed working drawings, full size, in any form of projection you choose other than that shown.

*Benchwork.*—Before commencing your work,

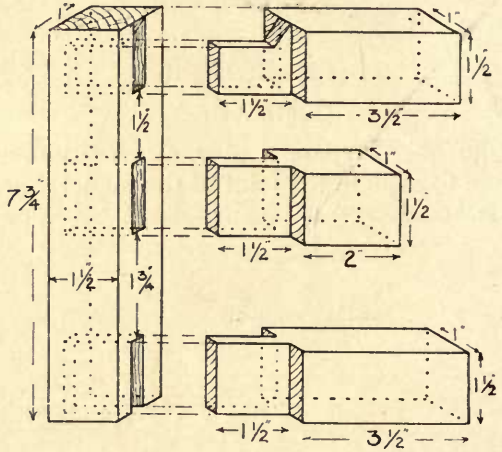



FIG. 60.—LETTER E.

Mortising and tenoning exercise. View in oblique projection of joints apart.

weigh the piece of wood, and make a note of its weight in your notebook.

Material suggested : yellow pine.

### QUESTIONS.

1. Give the names of any parts of the Manual Training-Room where you have noticed any of the joints of Lesson 32 used.

2. Make sketches of Rip, Hand, Tenon, and Bow saws, showing distinctly the form of the teeth of each.

3. Describe the Mortise gauge.

4. Weigh the wood after working the model. How much has been lost in working?

## LESSON 32a.

### MAGNETOMETER.

An instrument for comparing the relative intensities of magnetic poles.

It consists of a shallow box, the two graduated arms forming part of the bottom. Two of the

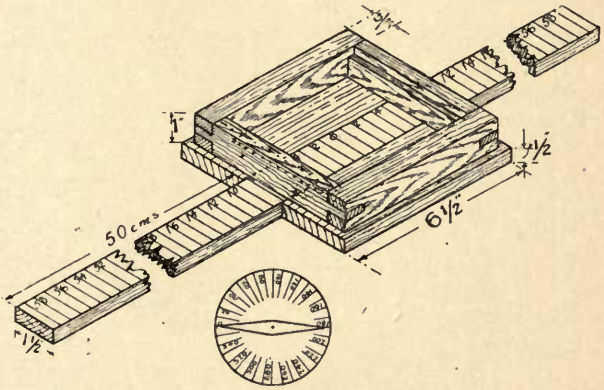



FIG. 61.—MAGNETOMETER.
Isometric view.

sides of the box have their top edges rebated to receive a piece of glass.

The magnet is placed on the graduated arms

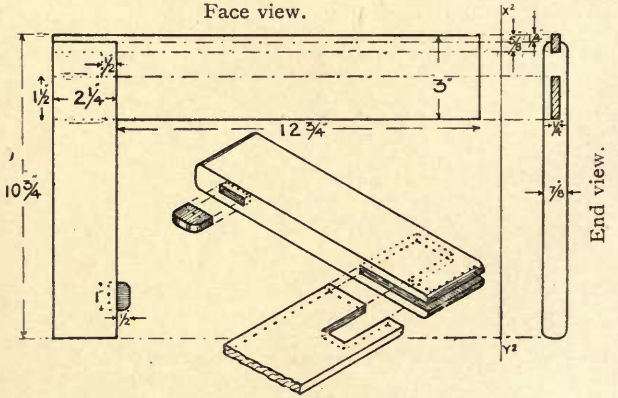
which point east and west. The magnetic needle is fixed on a fine-pointed needle, and moves round the paper scale marked in degrees. The magnetic needle should be so suspended that it moves with as little friction as possible.

*Drawing.*—Prepare working drawings of the magnetometer, introducing the most suitable joint of the three in Lesson 32.

*Benchwork.*—Execute the model in what you consider suitable material.

## LESSON 33.

### TRY-SQUARE.




Detail in isometric projection, showing joints apart.

FIG. 62.—WOOD-SQUARE.

*Drawing.*—Make a rough dimensioned sketch from an actual try-square, and from your sketch

only, and without reference to the square itself, prepare all the necessary working drawings.

*Benchwork.*—Material suggested: mahogany.

QUESTIONS.

1. Describe briefly the sharpening of saws.

2. Show by sketches how you would test the accuracy of a try-square, and apply those tests to the model you have made.

## LESSON 33a.

### A STAND TO ILLUSTRATE THE PARALLELOGRAM OF FORCES.

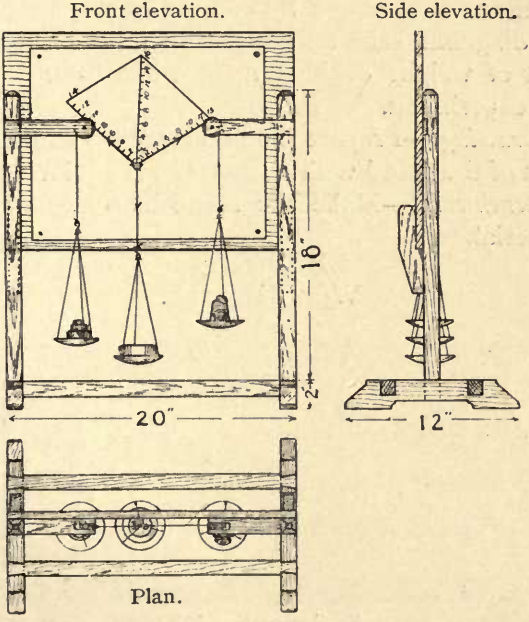



FIG. 63.

The arms of the wooden stand are fitted with small pulleys, round which string passes. Attached to the string are small pans or pill-boxes to carry the different weights used as the forces. Behind the stand a drawing-board is fixed, to which a sheet of drawing-paper is fastened. The drawing-board is fixed by means of cleats, which allow the board to be easily removed. Part of the diagram can be traced out on the drawing-paper when the board is in position, and the parallelogram afterwards completed to scale. The resultant is obtained by measuring the length of the diagonal, each unit of length representing the unit of weight decided upon when commencing the experiment.

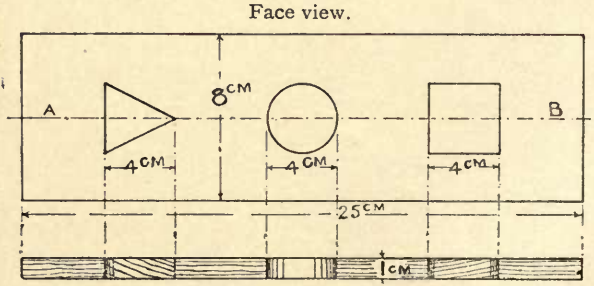
*Drawing.*—Prepare the necessary working drawings of the stand with sketches of the joints.

*Benchwork.*—Make the stand in some suitable material.

## LESSON 34.

### Wood Puzzle.

Face view.




Section on line AB.

Fig. 64.—Wood Puzzle.

*Drawing.*—A face view and section on AB are shown. Draw a view in isometric projection, full size. Make a freehand sketch of a block of wood which will fit each of the three holes.

*Benchwork.*—Material suggested: oak.

The circular hole to be worked with a centre-bit and scribing gouge.

QUESTIONS.

1. Give a brief description of oak.

2. How would you convert a log of oak into boards so as to show the medullary rays to their best advantage?

## LESSON 34a.

MODEL OF THE CAPSTAN.

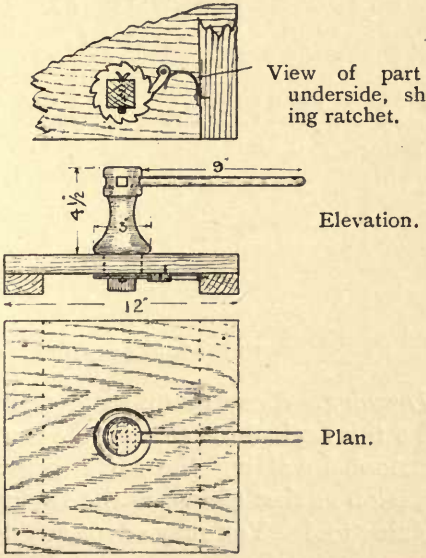



FIG. 65.—CAPSTAN.

This model can be used to illustrate in a modified form the principle of the wheel and axle.

In the capstan the axle is represented by the barrel, and the effort is applied at one or more points in a horizontal direction by means of the handspike.

*Drawing.* — Make working sketches of the model and a carefully-drawn detail of the ratchet mechanism.

*Benchwork.*—Where a lathe is available, the barrel may be turned. The ratchet wheel and catch may be shaped from pieces of brass.

## LESSON 35.

### Footstool.

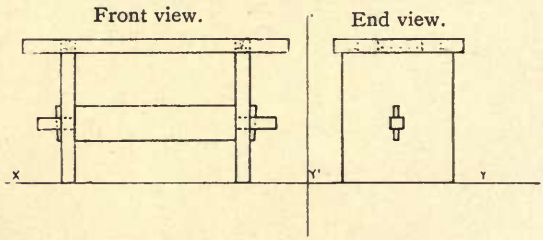



Fig. 66.—Footstool.

*Drawing.*—Construct a scale of one-third.

To this scale draw three orthographic views of a footstool, involving the same principles of construction as that shown in the two given views of a plain stool. You may adopt any design and any

dimensions you consider suitable. Make freehand sketches of the joints used.

*Benchwork.*—Material suggested: white-wood.

### QUESTIONS.

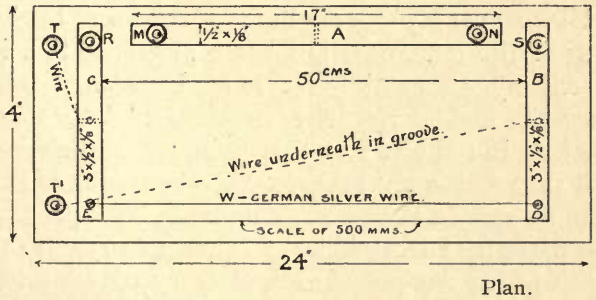
1. What points of difference are there between the trees and timbers of the white-wood and bass-wood?

2. If $\frac{7}{8}''$ white-wood is sold at $4\frac{1}{2}$d. per foot super, what will be the cost of the timber for twenty footstools?

3. Suppose you are paid at the rate of $8\frac{1}{2}$d. per hour for your labour, give the cost of the footstool in time and material (the latter to be determined in accordance with Question 2).

## LESSON 35a.

### A WHEATSTONE BRIDGE.




Plan.

FIG. 67.—A WHEATSTONE BRIDGE.

This consists of a deal board, $2' \times 4'' \times \frac{1}{2}''$, planed smooth both sides. Three pieces of copper or brass, one $17'' \times \frac{1}{2}'' \times \frac{1}{8}''$, and the remaining two

3″ × ½″ × ⅛″. File off rough edges and polish. Solder a rather thick copper wire to the middle of each piece underneath, as shown, one 24″ long and the other 30″ long, and a short one from top left hand binding-screw to brass plate of 8″ long. Each piece of brass should be filed across the middle, so that the wire, when soldered, lies flush with the surface. Drill holes near the ends of the brass pieces large enough to carry a binding-screw. Also drill smaller holes at D and E. Place the pieces on the board so that the inner edges of B and C are exactly 50 centimetres apart, and mark the position of the holes by pushing a bradawl through; then mark a place on the board at the points where the wires spring from the pieces. Remove the brass pieces, and bore holes through the board at the marked places.

Now solder a piece of German silver wire to the ends of the left and right brass pieces, so that it is exactly 50 centimetres long between them. Pass the end of the wire attached to A through the hole in the board at that point; pull the wire, and then fasten the brass in place by means of the binding-screws M and N. Similarly, after passing the wires from the middle of B and C through the holes, fasten one end of each piece by the binding-screws at R and S. Now place the other ends of B and C so that the wire W is rather tight, and then fasten them in position by the screws D and E.

Make two holes through the board at T and T′, and then, turning the board over, make a groove

from B to T′ for the wire to lie in, and another from C to T. Stretch the wires (shown by dotted lines), and place their ends in the holes, so that they are in metallic contact with the two binding-screws fixed at T and T′. Place a scale, divided into 500 millimetres, from end of wire W.

## LESSON 36.

### MARKING-GAUGE.

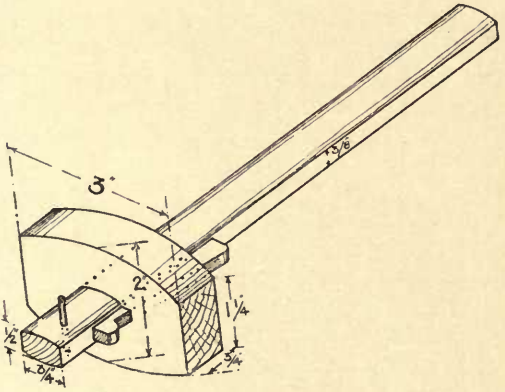



FIG. 68.—MARKING-GAUGE.
Isometric view.

*Drawing.*—An isometric view of the Gauge is given. Draw three orthographic views, full size, and give sketches of the spur and wedge.

*Benchwork.*—Material suggested: beech.

### QUESTIONS.

1. What are the products of the Beech-tree commonly used for?

Why are a Jack-Plane and a Smoothing-Plane each fitted with two irons?

## LESSON 36a.

### A Filter-Stand to carry Two Funnels.

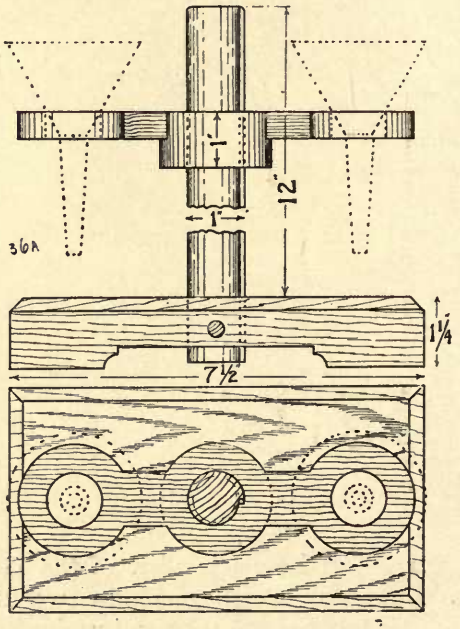



Fig. 69.—Filter Stand.

*Drawing.*—Prepare full-size working drawings.

*Benchwork.*—A cross section of the stem shows a cam-like shape; the support for the funnels is

fitted to this cam in such a manner that a slight horizontal turn looses it, allowing the support to be adjusted to any height. The base and stem are glued and pinned together.

## LESSON 37.

### DRAINING-STAND.

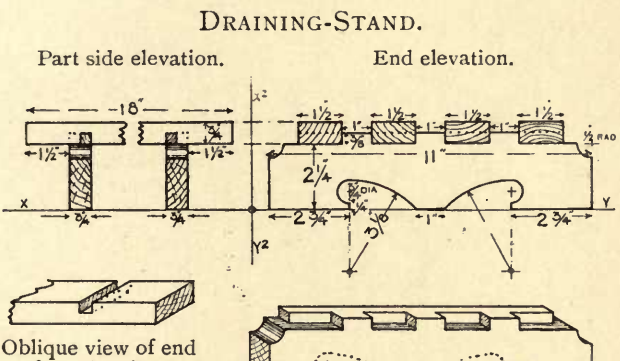



FIG. 70.—DRAINING-STAND.

*Drawing.*—Draw the two elevations as shown, and in place of the given oblique views of the details draw them in isometric projection.

*Benchwork.*—Material suggested: elm for feet, white deal for laggings.

### QUESTIONS.

1. Describe the tree and wood of the Elm, stating any special peculiarity it possesses. For what reason is it chosen for the draining-board?

2. Make a parcel of the draining-stand, and state what it would cost to send it to Chicago, U.S.A.

## LESSON 37a.

### Differential Air Thermometer.

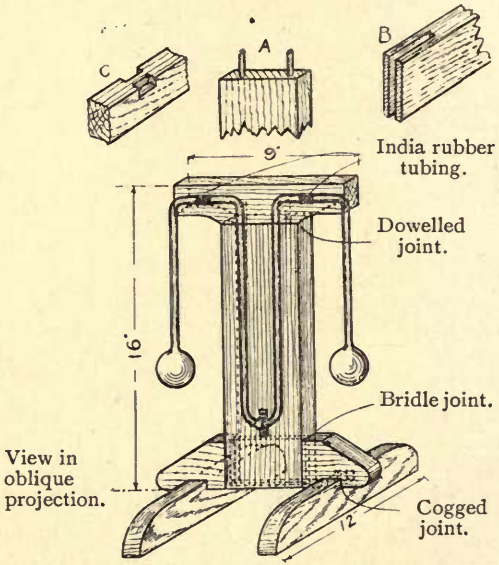



Fig. 71.—Differential Air Thermometer.

This consists of the wooden stand, provided with glass tubing, bent as shown. The end pieces are blown into bulbs and fitted to the bent **U**-tube by means of india-rubber tubing. A paper scale is pasted on the stand in such a way that the move-

ments of the liquid, placed in the bend of the U-tube, can be read easily.

*Drawing.*—A view in oblique projection is shown.

Draw two elevations and a plan. Make hand sketches of the joints.

*Benchwork.*—The top and upright pieces are dowelled together, as shown by detail A; the lower end of the upright piece is bridled into lower rail (see detail B), and the rail is cogged to the edges of the foot-piece (see detail C).

## LESSON 38.

### INKSTAND.

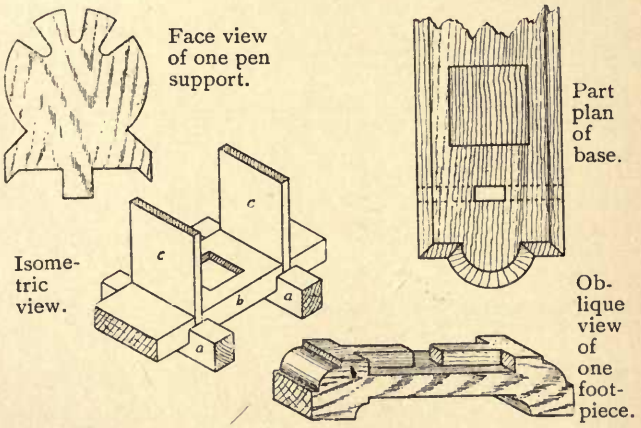



FIG. 72.—INKSTAND.

*Drawing.*—A plain model of the Inkstand is shown in isometric projection, and enlarged details are shown of the parts.

Draw two elevations and a plan, adopting what you consider to be suitable sizes.

*Benchwork.*—Material suggested: mahogany or walnut.

### Questions.

1. In what way is wood valuable commercially other than as timber?

2. If Mahogany is sold at 8s. 6d. per cubic foot, what is the value of the timber needed for twenty inkstands like the one you have made?

## LESSON 38a.

### An Electric Box.

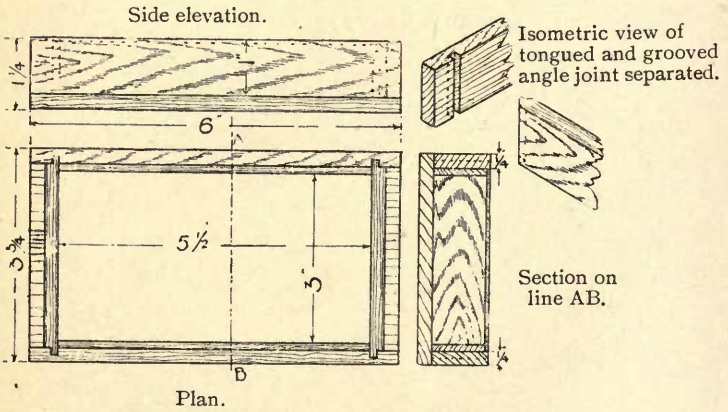



Fig. 73.—Electric Box.

*Drawing.*—Make an isometric view of the box, and a freehand sketch of tongued and grooved joint. This model is intended to illustrate three

principles in Statical Electricity: (*a*) The generation of electricity by friction; (*b*) the attraction of non-electrified bodies by a charged body; (*c*) the repulsion of bodies charged with like electricity.

(*a*) The glass cover on being rubbed with silk, woollen leather, or fur, becomes charged with electricity.

(*b*) Pith balls, grains of charcoal, bits of paper, or other light bodies inside the box, are drawn up to the glass cover.

(*c*) The light bodies, as soon as they become charged as in (*b*), suddenly shoot off the glass, and discharge their electricity on the tinfoil.

*Benchwork.*—The sides and ends are tongued and cross-grooved jointed, glued, and nailed together; two pieces to support the glass are glued to the sides, and the bottom nailed on to the sides and ends.

Before nailing, the parts should be sand-papered and the tinfoil glued to the bottom, the glue being spread on the bottom rather than on the tinfoil.

## LESSON 39.

### FIRE-SCREEN.

*Drawing.*—Two elevations of a fire-screen and enlarged details of the joints are given. Prepare the necessary working drawings, making any alterations in the ornamental parts of the design you think desirable.

*Benchwork.*—Material suggested: oak or mahogany.

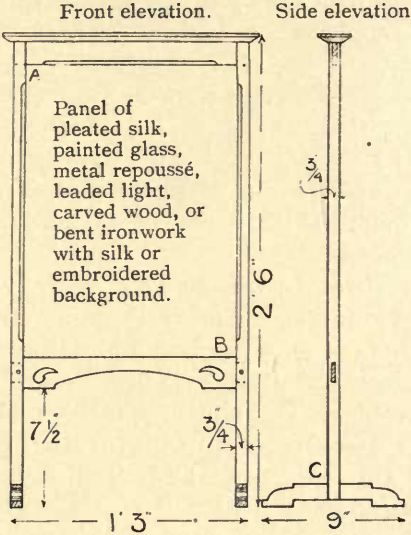



FIG. 74.—FIRE-SCREEN.

## QUESTIONS.

1. Make a freehand sketch of a vertical section of a Jack-Plane, in exact working order, the section to be taken in the centre from nose to heel (City and Guilds, 1901).

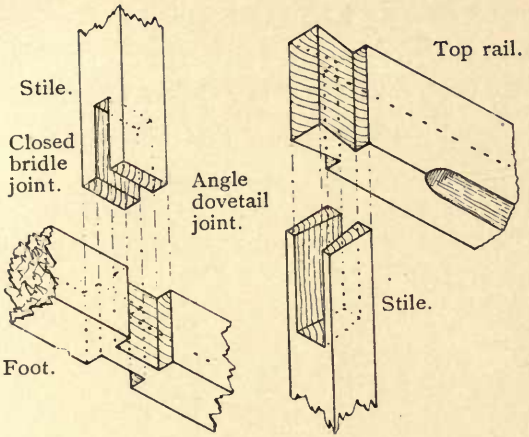



FIG. 75.—FIRE-SCREEN.
Details of joints at A and C.

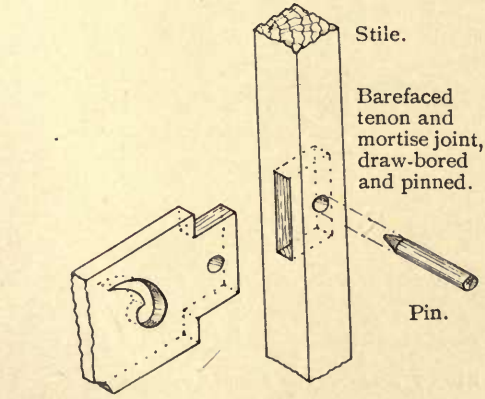



FIG. 76.—FIRE-SCREEN.
Detail of joint at B.

## LESSON 39a.

### Apparatus to prove Boyle's Law for Pressures Greater or Less than One Atmosphere.

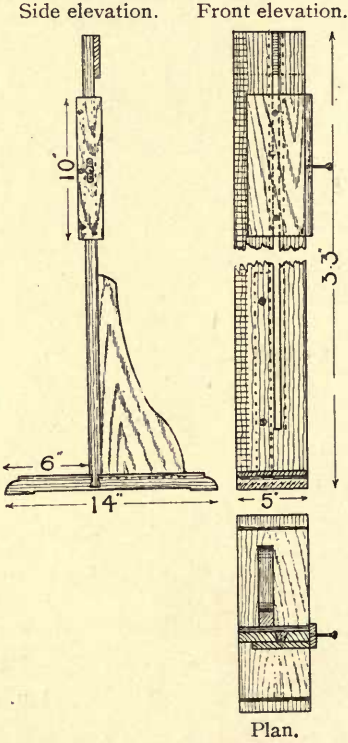



Fig. 77.—Boyle's Law Apparatus.

*Drawing.*—Prepare what you consider to be the necessary working drawings.

*Benchwork.*—The glass tubes are burettes, to which india-rubber tubing is attached, and made fast by copper wire wound round the parts of the burettes which fit in the tubing. The tube on the right is moved up and down by means of the wooden carriage to which it is fixed, and the height of the mercury in each tube is readily ascertained by noting the levels on the divided scale.

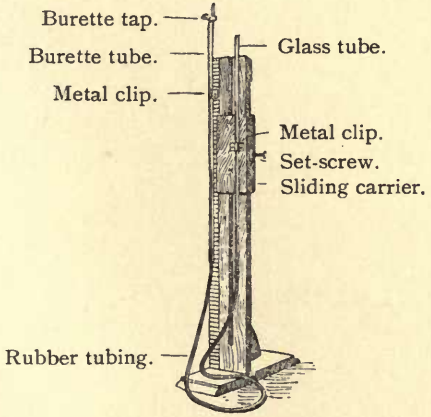



FIG. 78.

The base and upright are dovetail tongued and grooved together; the upright is supported by a bracket piece, to which it is screwed.

The drawings show the construction of the carriage, part of which slides in the dovetail groove of the upright.

## LESSON 40.

### Model of Original Design.

*Drawings.*—Prepare drawings of a model of your own design, together with a list of materials required.

*Benchwork.*—When your drawings are approved, work your model in the material you have suggested.

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*The authors are indebted to the* MANUAL TRAINING MAGAZINE *of America for the suggestion of models* 42*a*, 48*a*, *and* 56*a*.

# WOODWORK FOR SCHOOLS

## PART III

### LESSON 41.

MITRED PICTURE-FRAME.

*DRAWING.*—You may bring a picture or a piece of mirror-plate to be framed.

Design a section of moulding, and project from

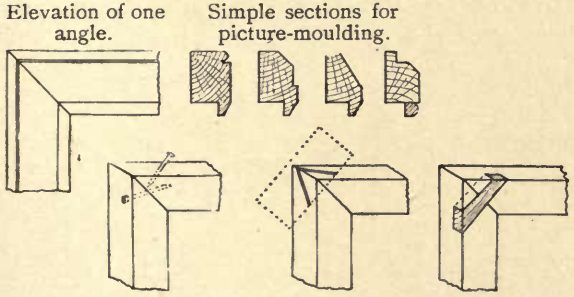

Elevation of one angle.
Simple sections for picture-moulding.
(*a*) Glued and nailed.
(*b*) Glued and slip-feathered.
(*c*) Glued and keyed at back.

FIG. 79.—MITRED PICTURE-FRAME.

Oblique views of alternative jointing.

your section the elevation of the frame. The sections given are merely suggestive.

*Benchwork.* — Prepare the moulding, mitre together, and secure with glue and nails, or by the insertion of a piece of veneer in a saw-kerf in the angle.

Heavier frames may be keyed at the back, as shown by *c* in Fig. 79.

QUESTIONS.

1. Show a vertical section through the centre of a gluepot.
2. Why should the inner vessel have its lower part in water ?

## LESSON 41a.

PHOTOGRAPHIC PRINTING-FRAME.

*Drawing.* — Prepare working drawings or sketches of the Frame, making freehand sketches of the jointing.

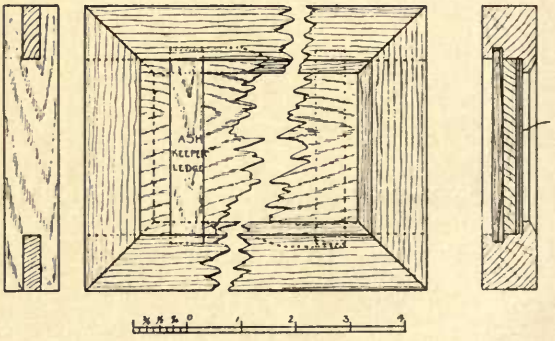



FIG. 80.—PHOTOGRAPHIC PRINTING-FRAME.

*Benchwork.*—The Frame is to be mitred, mortised, and tenoned together, rebated and chamfered, and mortises prepared for the keeper ledges; the

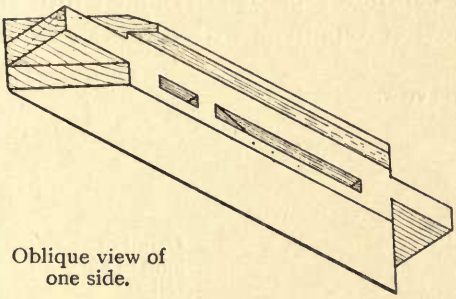



FIG. 81.—PHOTOGRAPHIC PRINTING-FRAME.

latter are to be rounded on the side adjacent to the back piece, so as to act like springs.

Wood suggested: mahogany for frame, any kind of wood for back, and ash for keeper ledges.

## LESSON 42.

### DROP-LEAF BRACKET.

*Drawing.*—From the plain model views draw and design a Drop-Leaf Bracket.

The maximum sizes are to be as follows:

Length, 2′ 6″; height, 3′ 6″; projection from wall, 1′ 8″.

*Benchwork.*—The two pieces forming the back are to be mortised and tenoned together.

The horizontal part of the back is screwed to the fixed part of the top; to the latter the remaining portion of the shelf is hinged.

The cantilever piece is tenoned into the back and draw-bore pinned, with a bracket underneath.

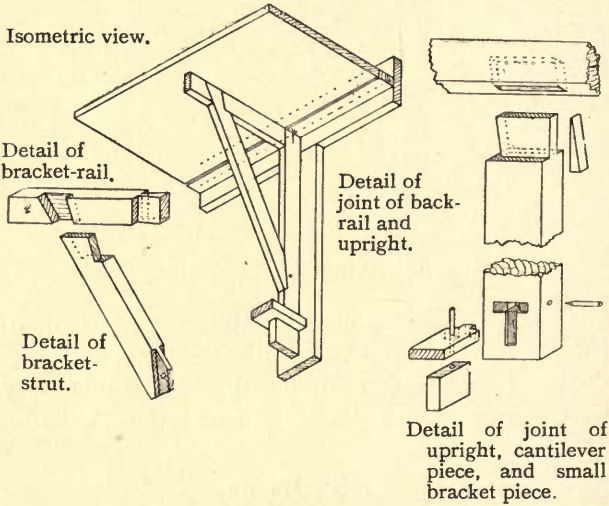

Isometric view.
Detail of bracket-rail.
Detail of bracket-strut.
Detail of joint of back-rail and upright.
Detail of joint of upright, cantilever piece, and small bracket piece.

FIG. 82.—DROP-LEAF BRACKET.

The pivoted bracket is framed, the joint at the right angle being dovetail tenoned. The upper end of the compression bar is dovetail halved, and the lower end tenoned, notched, and pinned.

## QUESTIONS.

1. What is brass?
2. How can it be softened for easier working, and how hardened again?

## LESSON 42a.

### HYGROSCOPE.

The Hygroscope serves as a weather indicator, in so far as it responds to the humidity of the atmosphere. The violin string absorbs moisture from the air and untwists, thus causing the man to come out. When the air becomes dry, the string twists tighter, thus causing the woman to come

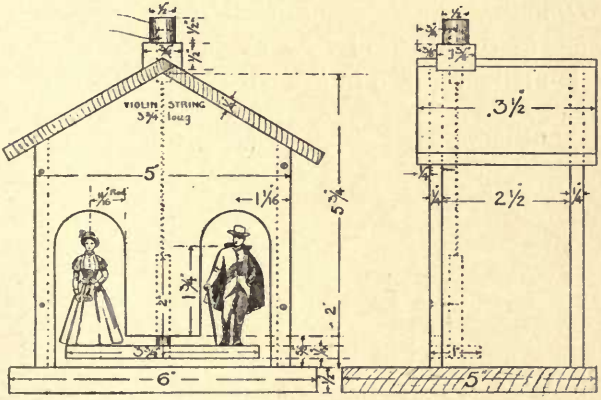



FIG. 83.—HYGROSCOPE.

out. The Hygroscope should be placed out of doors, but not exposed to rain or sunshine.

*Drawing.* — Prepare the necessary working drawings.

*Benchwork.*—Nail the back to the sides and screw on the front; fit and fix the roof, nailing into the sides and back only.

Nail the bottom on, and fix the chimney. Fix

the dowels, one into the chimney, the other into the platform, and secure the violin string by means of glue and wedges into the ends of the dowels.

The figures may be modelled in cardboard, clay, or wood; or they may be cast in plaster of Paris.

## LESSON 43.

### Common Angle Dovetail Joint applied to Corner Bracket.

*Drawing.*—Prepare working drawings of a corner bracket; the angle of the two bracket pieces is to be jointed as shown in isometric.

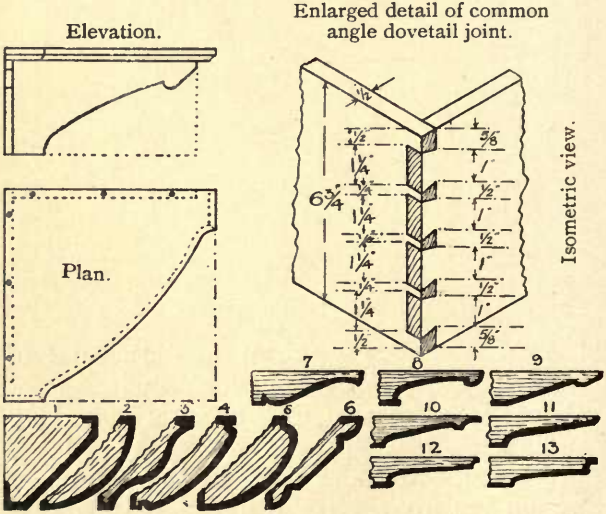

Elevation.
Plan.
Enlarged detail of common angle dovetail joint.
Isometric view.
6¾
1 to 6: Suggestions for treatment of shelf.
7 to 13: Suggestions for treatment of bracket.

Fig. 84.—Corner Bracket.

Draw orthographic views of the joint shown in Fig. 84.

Various forms for the treatment of the shelf and bracket pieces are shown; you may adopt or modify any of these as you think best.

*Benchwork.*—The bracket pieces are to be dovetailed together and glued; the shelf and bracket pieces to be screwed together.

### Questions.

1. Classify the following timbers under the headings of (*a*) Conifers and (*b*) Leafy Timber Trees:

Virginian Red Cedar, Beech, Ash, Yellow Deal, Spruce Fir, Oak, Yellow Pine, Elm, Teak, Walnut, Larch, Whitewood, and Mahogany.

2. Make a list of the above-named timbers in the order of their hardness.

## LESSON 43a.

### An Undershot Water-Wheel.

An Undershot Water-Wheel is turned by the water passing beneath.

An elevation and plan are shown in Fig. 85, the paddles being radially arranged.

A and B (Fig. 86) are alternative methods of shaping the float-boards or paddles.

Fig. 86 is a section of a wheel showing the paddles arranged at 30° to the radii. The mill-race is to be confined in the troughs shown.

*Drawing.*—Prepare working drawings of an Undershot Water-Wheel. You may please yourself

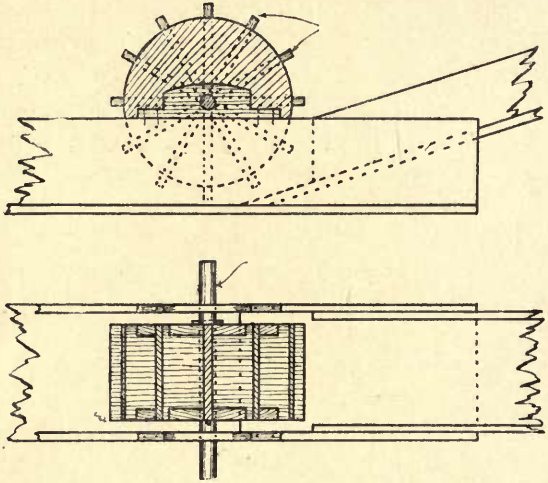


FIG. 85.—UNDERSHOT WATER-WHEEL.

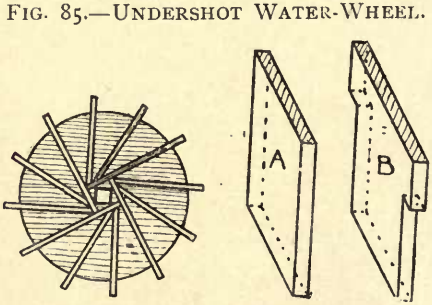



FIG. 86.—UNDERSHOT WATER-WHEEL.

as to the dimensions of the parts, and also as to the shape and arrangement of the paddles.

You may add some construction to contain the water at the head, and to receive it at the end of the trough.

*Benchwork.*—Make the Water-Wheel as shown by your drawings.

## LESSON 43b.

### MOTH-TRAP AND MOUNTING-BOARDS.

*Drawing.*—Prepare working sketches of the Moth-Trap and Mounting-Boards to sizes most suited to your purpose.

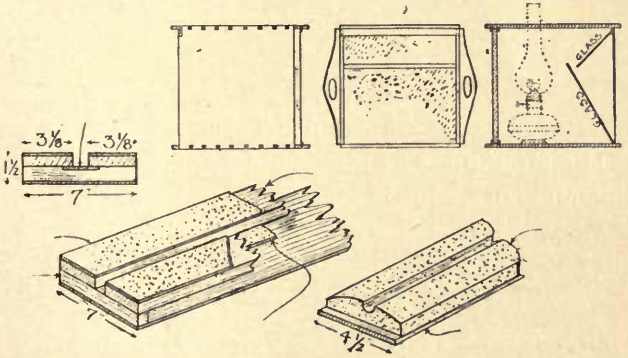



FIG. 87.—MOTH-TRAP AND MOUNTING-BOARDS.

*Benchwork.*—Make the Moth-Trap in accordance with your sketches.

The two pieces of glass may lie in grooves in

the two sides, or between small beads bradded to the sides.

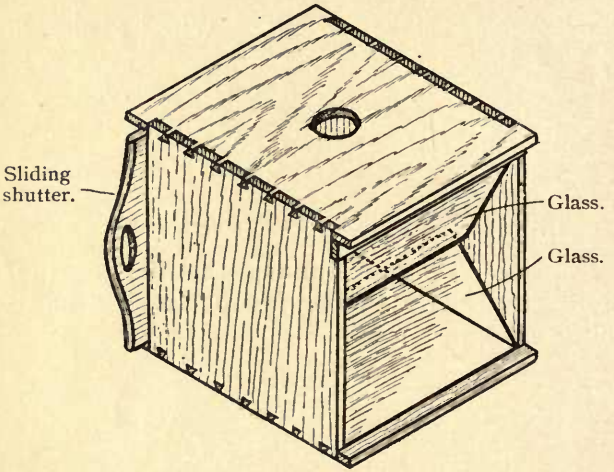



FIG. 88.—MOTH-TRAP.

The Mounting-Boards should be made of yellow pine and cork, glued together.

## LESSON 44.

### HAMMER-SHAFT.

*Drawing.* — Prepare working dimensioned sketches for a Hammer-Shaft.

*Benchwork.*—Work the Hammer-Shaft in accordance with the dimensioned sketches, using ash or hickory.

### QUESTIONS.

1. Describe the Ash and its products.

## LESSON 44a.

### An Overshot Water-Wheel.

The Overshot Water-Wheel requires much less water to produce the same effect than that required for an Undershot Water-Wheel. The water is

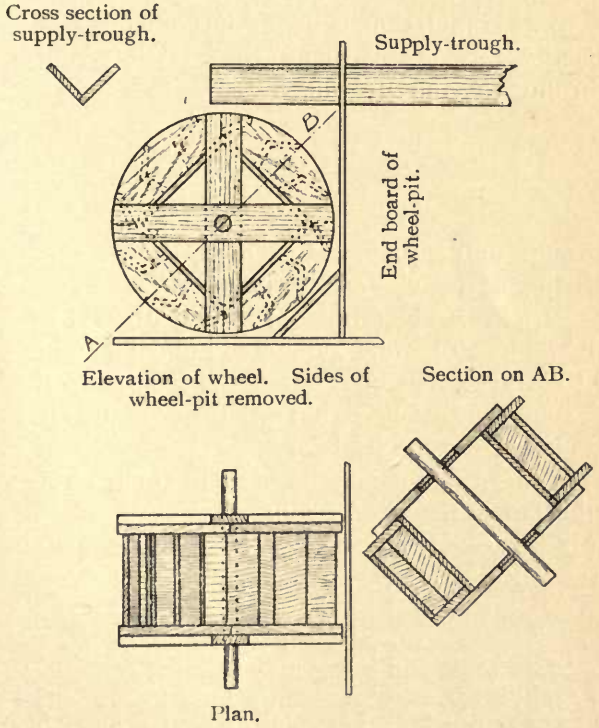



FIG. 89.—OVERSHOT WATER-WHEEL.

conducted by a trough to the top of the wheel and falls into bucket-like paddles; the wheel turns in the direction of the descending water. An elevation and plan of the wheel are shown in Fig. 89. The bearings and parts of the wheel-pit are omitted.

*Drawing.*—Prepare dimensioned drawings of an Overshot Water-Wheel and any other parts necessary to its completion as a working model.

*Benchwork.* — Construct the Water-Wheel according to your drawings.

## LESSON 45.

### Letter-Rack.

Design and execute a hanging Letter-Rack, consisting of a back and two or more leaves.

The back is to be formed of several strips of two or more kinds of wood jointed and glued together, and the leaves are to be fretted and secured to the back in such a manner that when not in use they may close on to the back.

Thin sheet-metal may be used in this exercise in addition to the wood required.

It is suggested that the design should be based on the Gothic style.

### Questions.

1. State what you know about Teak.
2. Oak has been displaced by Teak in the backing of warships' armour-plates. Why has this been done?

## LESSON 45a.

### Apparatus for Determination of Intensity of Gravity.

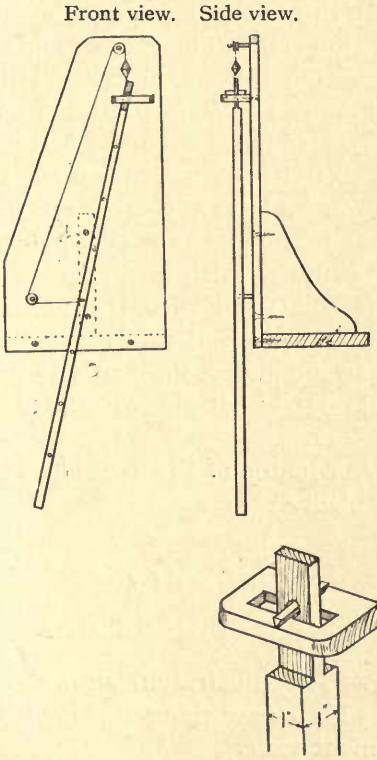



Fig. 90.—Apparatus for Determination of Intensity of Gravity.

This consists of an upright frame of wood, about 3′ high. It is supported by a ledge at the back, so that it can be used on the edge of the bench.

Almost at the top is a platform of hard wood, provided with a slot. The platform is screwed to the support. On this platform the knife-edge of the pendulum rests. The pendulum is a bar of wood about 4′ long and 1″ square. It is cut away at the top, so that it can swing freely in the slot of the platform. Holes at right angles to the plane of oscillation are bored in the pendulum.

A silk thread, to which a double conical bob is attached, is connected with the pendulum, and passes over two light pulleys, as seen above.

Small boxwood pulleys, bushed with glass tubing and pivoted on steel hat-pins with large heads, can be used.

The sharp equator of the bob is smeared with Brunswick black.

## LESSON 46.

### Bat-and-Ball Trap.

*Drawing.*—The illustration shows a Bat-and-Ball Trap. Prepare working drawings of the same to a convenient scale.

*Benchwork.*—Make the stock of the trap from a moderately hard wood, use beech for the trigger, and a long screw for the pivot.

QUESTIONS.

1. What kinds of timber do you consider the most suitable for making the following objects?

Bread-Board, Rolling-Pin, Cricket-Bat, Pantry

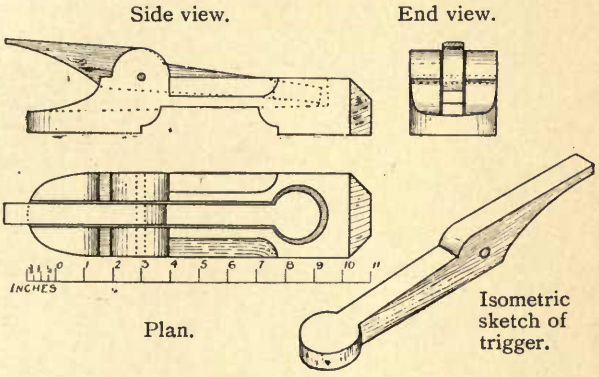



FIG. 91.—BAT-AND-BALL TRAP.

Shelves, Chair, Fence, Archery Bow, Trying-Plane, Cart-Shaft, Flagstaff, Drawing-Board, Rowing-Oars, Tee-Square.

Give reasons for your answer in each case.

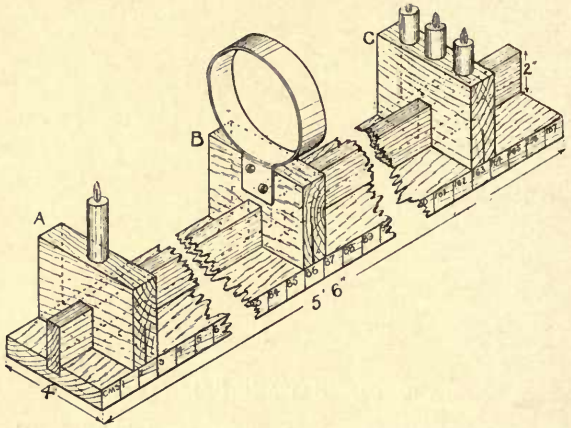
## LESSON 46a.

PHOTOMETER.

This consists of a board 5′ 6″ long, 4″ broad, and $\frac{3}{4}$″ thick. The three carriers, A, B, and C, slide along the centre beam; A and C are bored to carry candles; the centre carrier, B, carries a metal ring, which may be made from a canister-lid; a

second canister-lid rim, with a piece of paper tightly stretched over it, fits inside the first.

*Drawing.*—Make two elevations and freehand sketches to explain the details sufficiently.




View in isometric projection.

FIG. 92.—PHOTOMETER.

*Benchwork.*—The model may be executed in Whitewood or Deal.

The groove in the base-board may be worked with a cutting gauge, chisel, and router, should a plough not be available.

## LESSON 47.

### BAT FOR BALL-TRAP.

Design and execute a small bat for use with the Ball-Trap, using some suitable wood, such as willow.

### QUESTIONS.

Make sketches of six kinds of common Tree-Leaves to illustrate 'plain,' 'serrated,' and 'lobed' margins, and name each kind correctly.

## LESSON 47a.

### SONOMETER.

*Drawing.*—Prepare such drawings or sketches as you consider necessary.

*Benchwork.*—Fix the board and the box together, and secure to the two supports. At 1″ from one

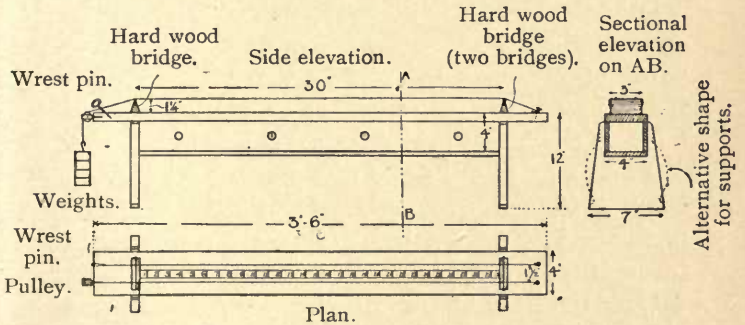



FIG. 93.—SONOMETER.

end of the board make two holes, 1½″ apart, for two iron screws, which must be screwed into the holes until their heads are about ⅛″ above the board. The holes are to be so bored that the heads

of the screws are slightly inclined towards the end of the board. At the other end of the board fix a small pulley and an iron 'wrest-pin,' the latter inclined at an angle of 45°. The pulley is to be near enough to the end of the board to allow a wire passing over it to hang freely, and of such a height that the wire rests upon, but is only just deflected by, the edge of the bridge. The wrest-pin is to fit the hole stiffly, so that it may be turned with a key. Two hard-wood bridges are to be cut, $3'' \times 1\frac{1}{4}'' \times \frac{3}{4}''$; the upper side of each bridge is bevelled to a blunt edge, and along this edge is fixed a stout brass wire for the stretched wires to bear upon.

Glue the bridges in position equidistant from the ends of the board, with the centres of the brass wires exactly 30″ apart. Make a scale between the bridges 30″ long and divided into $\frac{1}{8}''$, and fix it on the board between the bridges.

Twist a loop at the end of a steel or other wire, about 3′ 6″ long, and slip it over the head of one of the screws on the board. Pass the other end through the wrest-pin.

Over the head of the other screw loop a similar piece of wire. Pass the other end of the wire over the pulley, and at the end make a loop from which to hang weights.

Make two movable bridges $\frac{1}{8}''$ higher than those at the end, and face these also with brass wire.

## LESSON 48.

### BOOK-STAND.

*Drawing.*—Prepare working drawings of a Book-Stand, adopting dimensions most suitable to your own requirements.

Fig. 94 illustrates the method of construction to be adopted.

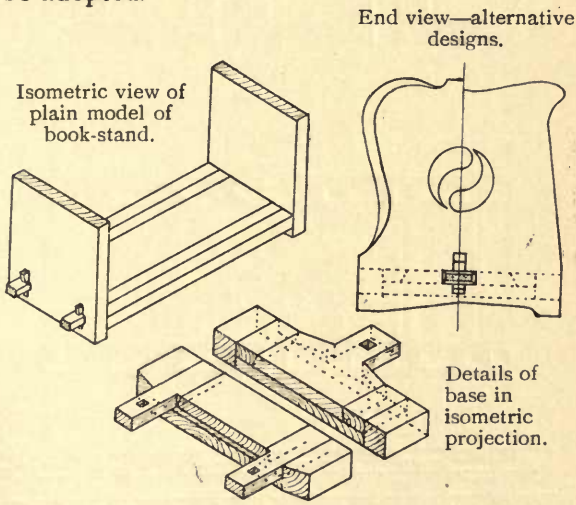



FIG. 94.—BOOK-STAND.

*Benchwork.*—The upper middle piece of the base is loose, and is connected to one end piece by a keyed tenon, thus allowing the stand to be extended to accommodate more books.

The remaining five pieces of the base may be

made of different coloured woods, jointed and glued together.

Ribbon inlay work may be appropriately used

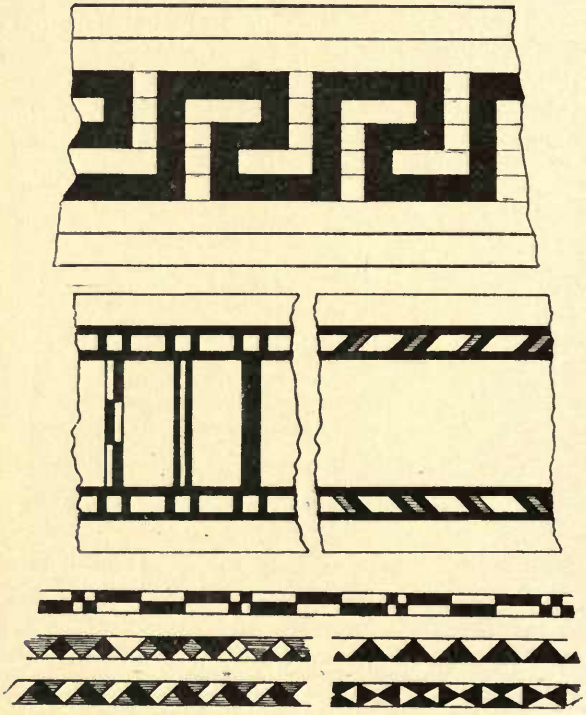


FIG. 95.—BOOK-STAND: SUGGESTIONS FOR INLAY.

for the decoration of the Book-Stand. Some suggestions for this are shown in Fig. 95.

In Fig. 94 are suggested two methods of treating

the ends, but you are to endeavour to produce a design of your own.

### Questions.

1. Make a sketch of a Bow-Saw; name the parts, and state of what material each is made.
2. What mechanical principles are illustrated in the construction of the Bow-Saw?

## LESSON 48a.

### Electrical Battery.

*Drawing.*—Make a rough sketch of a Battery, and name the parts.

*Benchwork.*—The jar may be a fruit-jar, with its top removed by means of a hot wire.

The carbons are those used for street electric lights. Cast two pieces of zinc in a mould. Four carbons, properly insulated from the zinc, but connected by a strip of copper, are clamped on each side of the zinc, two bolts passing through wooden side pieces binding the parts together.

The solution is composed of 12 parts (by weight) bichromate of potash, 25 parts sulphuric acid, 100 parts of water. After the bichromate has dissolved in the water, mix in the acid slowly.

The batteries should be removed from the solution when not in use.

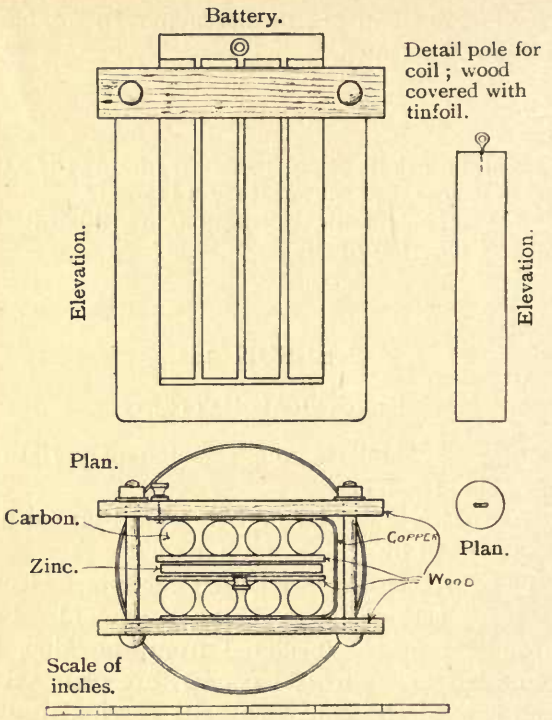



FIG. 96.—ELECTRICAL BATTERY.

## LESSON 49.

BRUSH-BRACKET AND MIRROR-FRAME.

*Drawing.* — The principles of construction involved in making the bracket are shown in Figs. 97 to 98.

Make working drawings, adopting whatever sizes and decorative treatment you consider best.

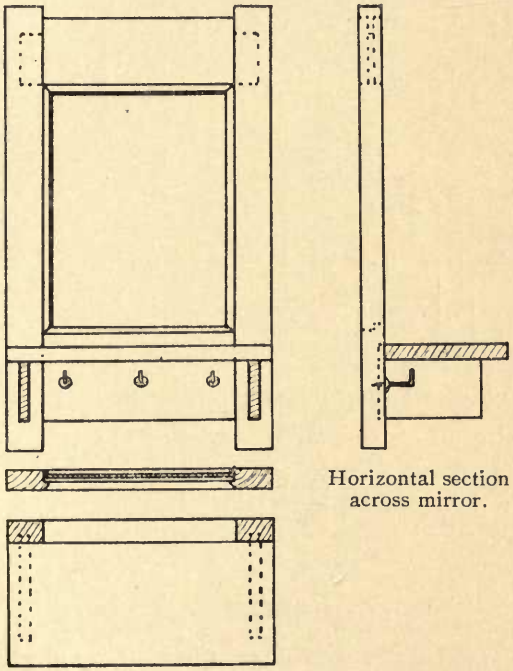



FIG. 97.—BRUSH-BRACKET AND MIRROR-FRAME.

*Benchwork.*—Suggest a suitable material, and execute the bracket in accordance with your drawings.

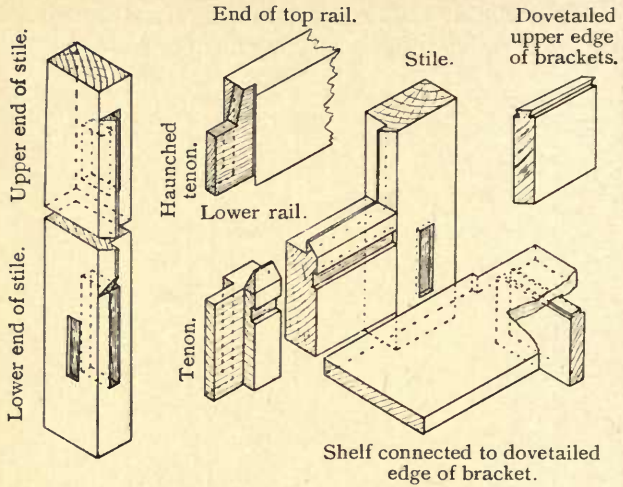



FIG. 98.—BRUSH-BRACKET AND MIRROR-FRAME.

Details of jointing.

QUESTIONS.

Describe the Birch-Tree and its products.

## LESSON 49a.

SCALE-BOARD FOR USE WITH REFLECTING GALVANOMETER.

*Drawing.*—Make a dimensioned sketch of the Scale-Board.

*Benchwork.*—Prepare the three pieces of wood; screw the base and upright pieces together, and hinge the cover piece to the upright piece.

Shape a piece of brass as shown, fix it, and use

a binding-screw, so that the cover piece may be fixed at any desired angle.

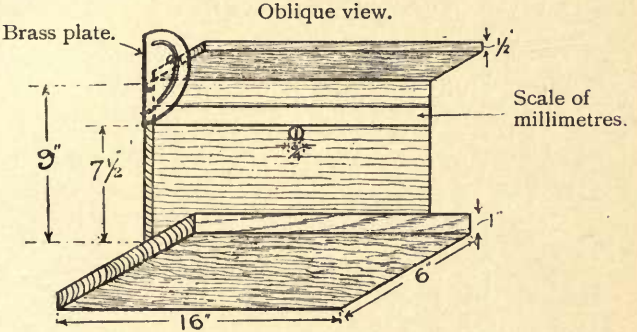



FIG. 99.—SCALE-BOARD FOR USE WITH REFLECTING GALVANOMETER.

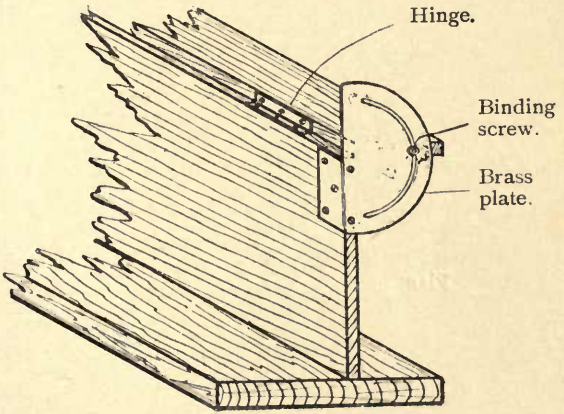



FIG. 100.—SCALE-BOARD FOR USE WITH REFLECTING GALVANOMETER.
Oblique view.

Measure out a scale of millimetres upon a slip of paper, and glue it to the upright board.

## LESSON 50.

### DWARF-STAND.

*Drawing.*—Prepare working drawings of the Stand, making whatever modifications you like in

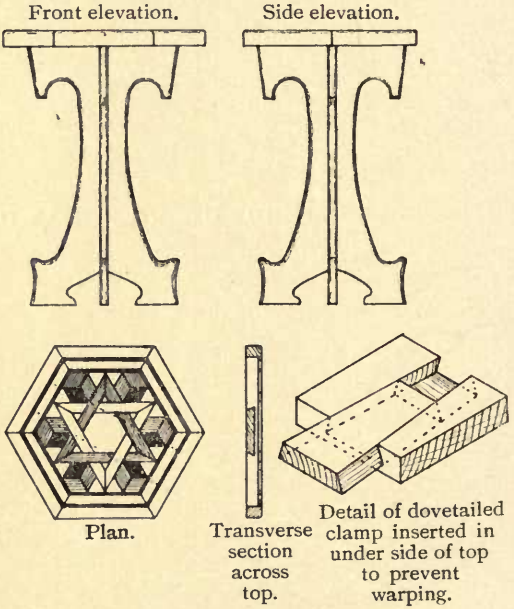

Front elevation.
Side elevation.
Plan.
Transverse section across top.
Detail of dovetailed clamp inserted in under side of top to prevent warping.

FIG. 101.—DWARF-STAND.

the design, but retaining the same methods of construction.

*Benchwork.*—Make the Stand to your drawings.

## Questions.

1. Sketch a longitudinal section from nose to heel of the smoothing-plane, giving special attention to the action of the back iron when removing a shaving.

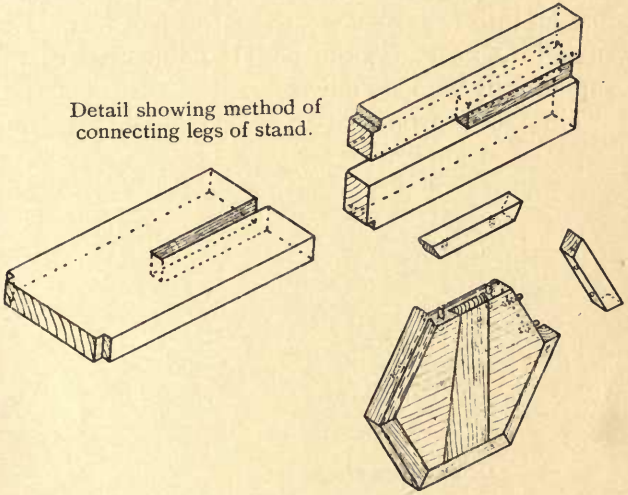

Detail showing method of connecting legs of stand.
View of under side of top, showing clamp, key and dowelled connections for margin pieces.

Fig. 102.—Dwarf-Stand (Details).

2. Beech planes require 'remouthing' after several years' service. Explain the necessity for this.

## LESSON 50a.

### Tangent Galvanometer.

*Drawing.*—Prepare working drawings of the Tangent Galvanometer.

*Benchwork.*—The two supports are dovetail housed into the base, and the latter has two ledges sunk into its ends; the reel is connected to the supports by wooden dowels.

The reel is wound with No. 20 S.W.G. cotton-

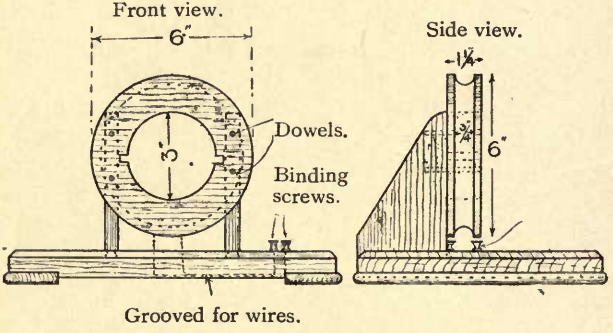



Fig. 103.—Tangent Galvanometer.

covered wire. The inner surface of the reel is so arranged that a box compass 3½" diameter can be fitted into the grooves shown.

The reel may be made from one piece of wood, or it may be built up of two, three, or four layers, glued and dowelled together. If the latter method is adopted, the grain of one piece should be placed at right angles to the grain of the adjacent piece.

## LESSON 51.

### CHESS-BOARD.

*Drawing.*—The illustrations shown in Fig. 104 are suggestions for making a Chess-Board.

Adopting the methods of construction there

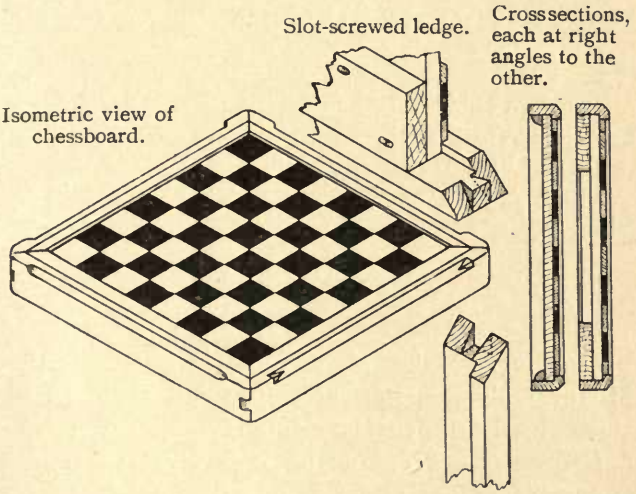

Slot-screwed ledge.
Cross sections, each at right angles to the other.
Isometric view of chessboard.
Detail of mitred and dovetailed mortise and tenoned joints of framing.

FIG. 104.—CHESS-BOARD.

shown, prepare working drawings in orthographic projection.

*Benchwork.*—Prepare the base first; glue the marquetry top upon the base, and then frame it.

The base should be made of Yellow Pine or Whitewood, with hard-wood ledges, slot-screwed to it. The marquetry squares may be of any two kinds of wood which will give a pleasing contrast, as White Holly and Ebony or Ebonized Wood, Sycamore and Black Walnut, Birch and Mahogany.

The frame may be of Oak, Mahogany, or Walnut.

QUESTIONS.

Explain the reasons for using:

(*a*) Water with the grindstone;

(*b*) Oil with the oilstone.

How would you 'true up' a grindstone and an oilstone?

## LESSON 51a.

MIRROR GALVANOMETER.

*Drawing.*—Make plan and elevation of the Mirror Galvanometer, and freehand sketches to show clearly all necessary details.

*Benchwork.*—Prepare the base and pillar, and connect together either by mortise and tenon or dowel jointing.

Make the reel, and fasten to the top of the pillar by means of a small angle piece of brass.

Where a lathe is available, the base, pillar, reel, and plug may be turned.

The wires used to wind round the reel are: No. 28 S.W.G., silk-covered, and No. 20 S.W.G., cotton-covered.

The brass rod to support the directing magnet is $\frac{1}{4}''$ diameter.

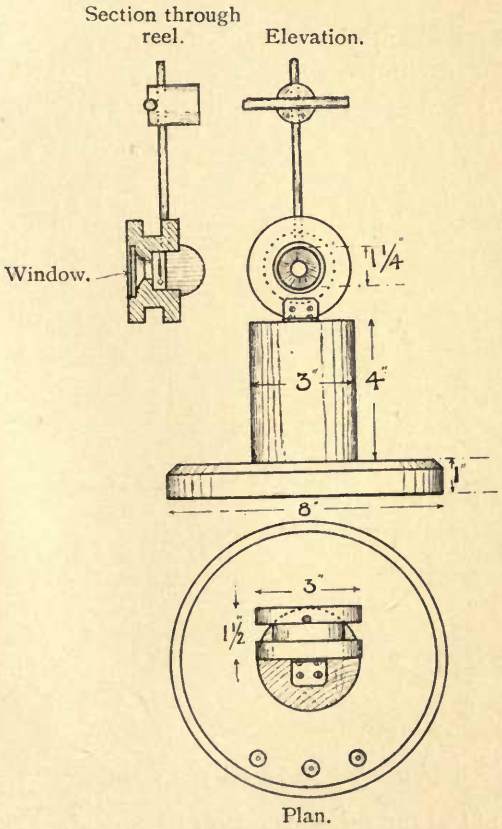



FIG. 105.—MIRROR GALVANOMETER.

## LESSON 52.

### NEEDLEWORK CABINET.

This model contains four small drawers for holding various sewing requisites.

Above the drawers is a pin-bowl, surrounded by

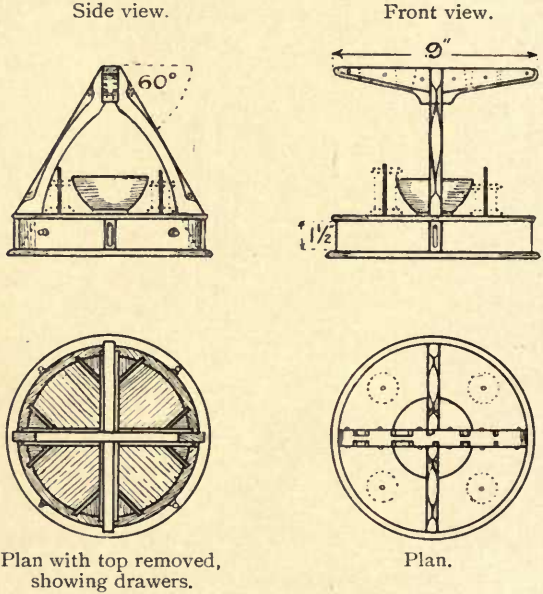



FIG. 106.—NEEDLEWORK CABINET.

metal pins to take reels of cotton or thread. The two arms at the top are notched on both sides to hold scissors, crotchet-hooks, etc., which are kept

in place by pieces of brass or copper-plate screwed to the arms.

The top edge of the arms may be marked in inches for measuring purposes. The length—viz., 9″—is a convenient length, being $\frac{1}{4}$ yard.

*Drawing.*—Prepare working drawings and sketch details of the Needlework Cabinet.

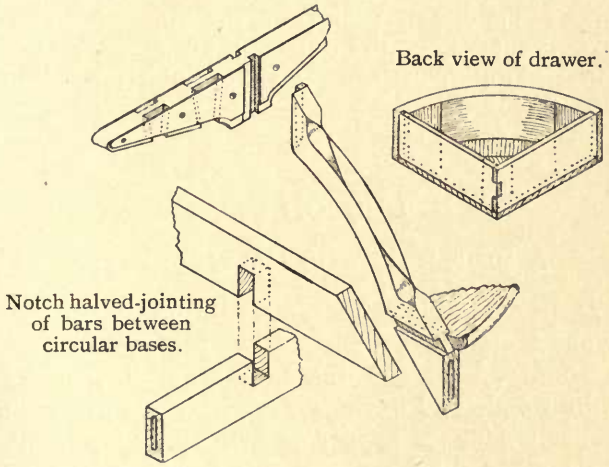



FIG. 107.—NEEDLEWORK CABINET (DETAILS).

*Benchwork.*—Work the circular base and surbase and screw to the cross-halved intermediate framing; connect the two inclined supports to these, and fit the top arms piece into place. The four pieces of brass or copper-plate, of about $\frac{1}{16}$″ thick, should be shaped with shears and files, drilled for screws, and secured to the arms with

round-headed screws. The pins for the cotton-reels may be made from round wire-nails, the heads of which have been filed off.

The pin-bowl offers scope for a large number of various designs and practice in modelling.

### Questions.

Show several arrangements of saw teeth to a large scale, clearly indicating the angle, set, etc., giving reasons for the differences of arrangement. For what purpose are saws without teeth used? How would you deal with a buckled saw blade? (N.U.T., 1905.)

## LESSON 52a.

### A Simple Astatic Galvanometer.

*Drawing.* — Make necessary working dimensioned sketches.

*Benchwork.*—Make the base from a piece of white-wood, and give it two or three coats of shellac. Make a copper or brass bridge 7″ high, $\frac{1}{2}$″ wide, $\frac{1}{16}$″ thick. Screw this to the outside of the block, so as to be rigid and firm.

Drill a small hole through the top of the bridge to admit a screw-eye for the suspension of the needles.

Take 10′ or 15′ of No. 30 wire and wind it in coils, and fasten the coils to base-board with small brass or copper straps and copper tacks or screws (do not use iron, steel, or tin).

A short piece of brass or wood will act as carrier for the needles.

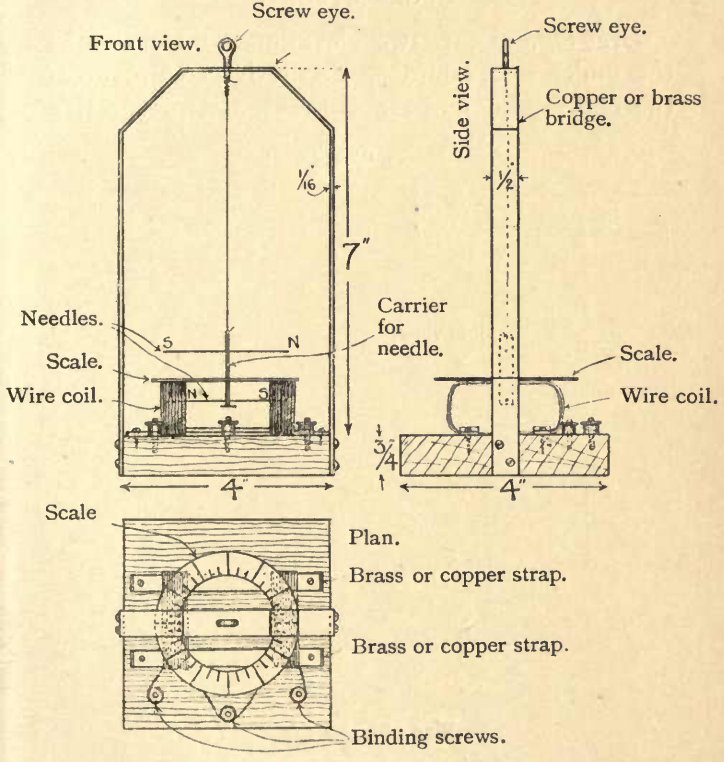



FIG. 108.—SIMPLE ASTATIC GALVANOMETER.

The binding screws are to be arranged as shown in the figure. The circular scale is fixed to the coils by means of paraffin wax.

## LESSON 53.

### Book-Support.

*Drawing.*—Draw two elevations and a view of the under side, adding a decorative treatment of the end. Also make a conventional perspective

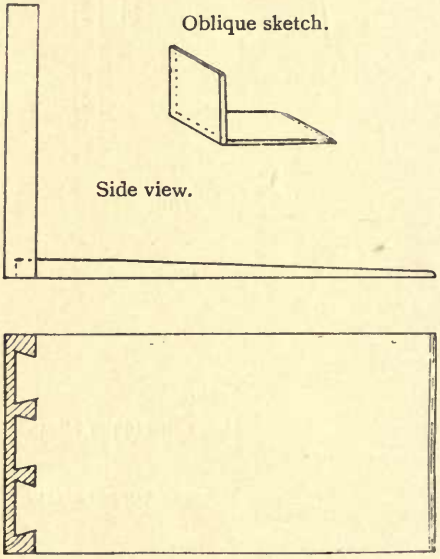



Fig. 109.—Book-Support.

view of the lap dovetail joint to show its construction to the best advantage.

*Benchwork.*—Make the Book-Support as shown by your drawings.

### Questions.

Describe any diseases to which timber is subject:
(*a*) In the tree;
(*b*) After conversion.

## LESSON 53a.

### Induction Coil for Telephone.

The wooden spool is to be turned from a piece of wood $3\frac{1}{2}'' \times 1''$ square. The core-sheath is turned down so that it is about $\frac{1}{16}''$ thick; it is covered

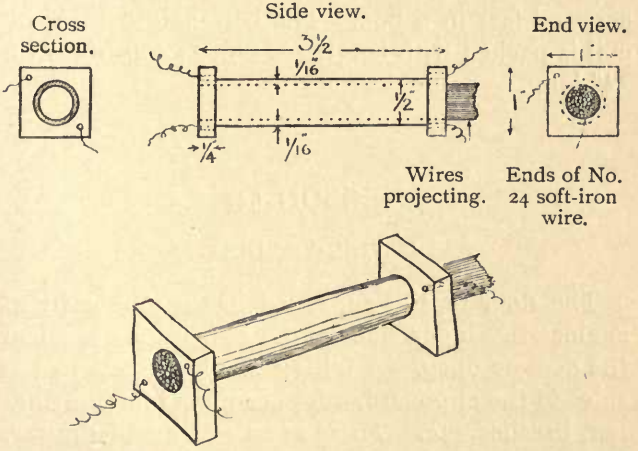



Fig. 110.—Induction Coil for Telephone.

with a coat or two of shellac, and two holes are made at each end. The wire is wound by apparatus made in Exercise 58a. The primary winding

is made up of two layers of No. 20 double-insulated copper wire, one end projecting from the hole at one end of the spool and the other from the hole at the other end. Two or three coats of shellac are then given to this coil, and over the layer a piece of paper is wrapped and covered with shellac. The secondary coil is made up of twelve layers of No. 34 silk-insulated wire, and over each layer a sheet of paper is wound to make two wraps, each being given a coat of shellac. When the winding is complete, three or four wraps of paper are added, the whole being covered with shellac. It is then screwed fast in a box. The core-hole within the coil is packed with lengths of No. 24 soft iron wire $3\frac{1}{2}''$ long.

## LESSON 54.

### Shaving-Cabinet.

The door of the cupboard has a mirror fitted against the inner side of the panel, for use when the door is open. A falling shelf, pivoted to the sides of the cupboard, affords support for shaving-pot, brushes, etc. There are also a small drawer, and a towel-rail, and two hooks for razor-strops are provided.

*Drawing.*—Prepare working drawings of the Shaving-Cabinet, making any modifications you consider best.

*Benchwork.*—Prepare and fit together the framework of the Shaving-Cabinet.

The door is to be haunched, mortised, and tenoned together, and rebated to receive panel and mirror, the latter to be secured with beads. The

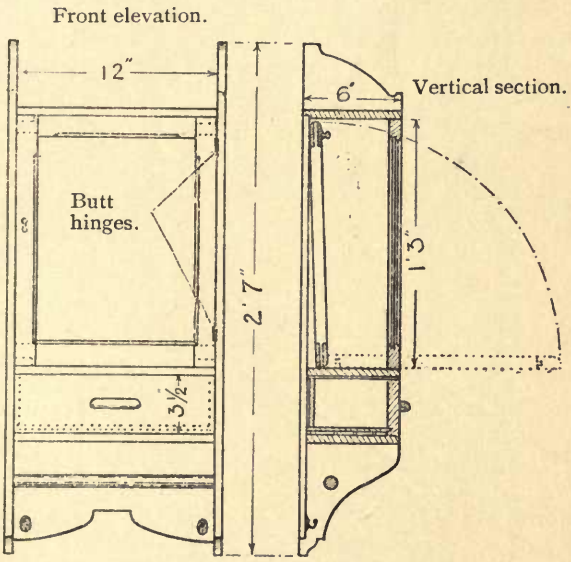
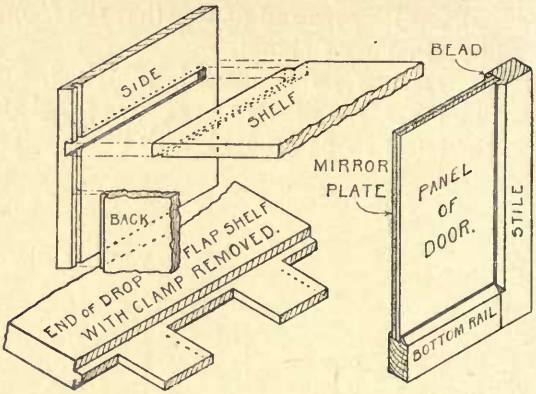


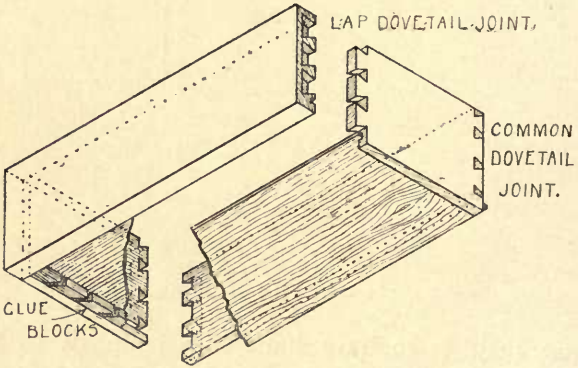

FIG. 111.—SHAVING-CABINET.

drop shelf is to have both ends clamped with mortise and tenon joints.

The sides, front, and back of the drawer are to be dovetailed together, the bottom mulleted into grooves and glue-blocked, and a drawer-pull of wood modelled and screwed from the inside.




Details of jointing.




Detail of drawer in isometric projection.

FIG. 112.—SHAVING-CABINET (DETAILS).

## QUESTIONS.

1. Describe what qualities should guide you in the selection of timber.

## LESSON 54a.

### TRANSMITTER OF TELEPHONE.

Block A may be made of pine, white-wood, or birch, $2\frac{3}{4}''$ square and $\frac{3}{4}''$ thick. A hole $\frac{7}{8}''$ in diameter and $\frac{1}{2}''$ deep is bored in the centre of the block, and a path is cut in the face of the block $1\frac{1}{2}''$ diameter and $\frac{1}{8}''$ deep.

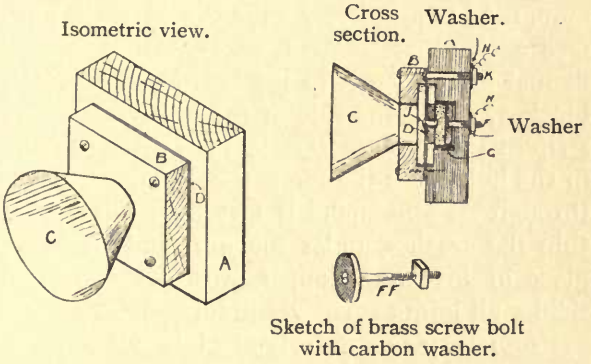



FIG. 113.—TRANSMITTER OF TELEPHONE.

A, Wood block back; B, face plate; C, mouth-piece; D, diaphragm of ferrotype plate; FF, carbon washer with brass screw and nut; G, felt or flannel; H, insulated copper wire; J, rivet securing diaphragm to carbon washer; K, fine bolt.

B face-plate is 2″ square, with a $\frac{3}{4}''$ hole in it, and the under side is cut away to a depth of $\frac{1}{8}''$ and a diameter of $1\frac{1}{2}''$. This allows space for the diaphragm D to vibrate when the sound of the voice falls on it, through mouthpiece C.

From carbon $\frac{1}{8}''$ thick two round buttons are

cut, measuring $\frac{3}{4}''$ across. A small hole is bored in the centre of each button, and one of them is provided with a very small brass screw and nut, shown apart as FF. One side of the buttonhole is countersunk, so that the head of the screw will fit down into it and be flush with the face of the carbon. Cut the surface of the buttons criss-crosswise with a three-cornered file. When mounted in the receiver, the surfaces of the buttons face each other. Cut a small washer of felt or flannel and place it in the bottom of the hole in block A. Line the side of the hole with a narrow strip of the same material; then place the button in the hole, pass the screw through the button and through A, and make it fast with nut. Place a thin flat washer under the nut, and twist a fine piece of insulated copper wire for connections. Solder all joints whenever practicable.

From very thin ferrotype plate cut a piece 2″ square; at its middle attach the other carbon button by means of a small rivet, which can be made from a piece of copper wire; or a small brass machine screw may be passed through the button and plate. Gently tap to rivet it fast, as shown at J. Lay the block down flat and partly fill the cavity with powdered charcoal until the bottom is covered. Do not fill up to the top of the hole. Over this lay disc D, so that the carbon button on the under side fits into the top part of the hole and its felt lining. Fasten the disc to A with small pins. A fine bolt (K) is passed through the

block and disc, and is provided with a nut and washer similar to that at F for connection. Scrape the japan or lacquer from D where the bolt-head touches it. C is a small tin funnel fastened to B. B is screwed fast to A.

## LESSON 55.

### GONG-STAND.

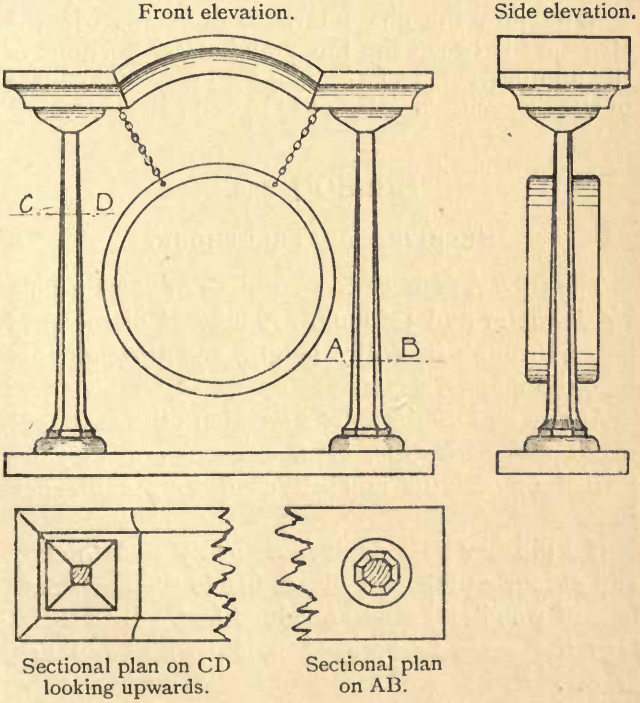



FIG. 114.—GONG-STAND.

*Drawing.*—Make working drawings of the Gong-Stand to suitable dimensions.

*Benchwork.*—Work the top from one piece of wood. Each of the pillars is to be worked in three pieces, dowelled together; the dowels are to protrude beyond the length of the pillars, and to connect the pillars to the top and base.

### Questions.

What are the characteristic differences in the structure between the inner and outer portions of the annular rings of the elm? Trace the causes of the differences. (C. and G., 1894.)

## LESSON 55a.

### Receiver of Telephone.

The tube A is made from a piece of curtain-pole $1\frac{1}{8}''$ diameter and $3\frac{1}{2}''$ long. A hole $\frac{3}{8}''$ diameter is bored through its entire length, and through this hole the magnet passes.

At one end of the tube a wooden pill-box (C) is made fast with glue, or a wooden cup may be turned on a lathe and attached to the magnet tube.

If a pill-box be used, it must be $2\frac{1}{2}''$ in diameter, and at four equidistant places inside the box small lugs of wood (D) are to be glued fast. Into these lugs the screws employed to hold the cap are driven.

The cap E is made of thin wood, fibre, or hard rubber. It is provided with a thin rim or collar to separate its inner side from the face of the disc K, which is made of very thin iron. Four small holes are bored near the edge of this cap, so that the screws which hold it fast to cup C may pass through them. The magnet B is a piece of hard steel $\frac{3}{8}''$ in diameter and $4\frac{1}{4}''$ long.

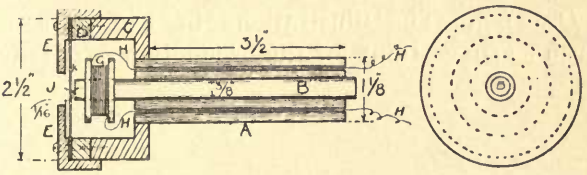



FIG. 115.—RECEIVER OF TELEPHONE.

A, Wooden tube; B, magnet (hard steel) $\frac{3}{8}''$ diameter; C, pill-box $2\frac{1}{2}''$ diameter; D, wood lugs; E, wood cap; F, thin iron disc; G, turned spool wound with No. 36 copper wire; H, thicker wires; J, hole.

Now have a thin, flat spool, turned from maple or boxwood, to fit over one end of the rod, and wind it with a number of layers of No. 36 copper wire.

Drop a little hot paraffin on the wire when it is in place, so that it will not unwind. The ends are fastened to thicker wires running through small holes in the tube A, and projecting at the end as shown.

The magnet is pushed through the hole in A

until the top end of the rod is slightly below the edges of the cup E, so that when the metal disc D is laid over the cup F, the space between the magnet and the disc D is $\frac{1}{16}$". Put a little shellac on the magnet, so that when in its right place it will be held fast.

## LESSON 56.

### TRAY.

*Drawing.*—The illustrations in Fig. 116 are given as suggestions for the production of a Tray.

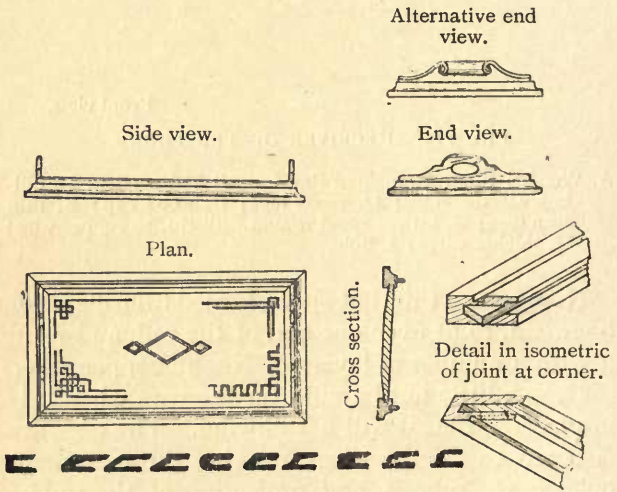



FIG. 116.—INLAID TRAY.

Prepare designs and working drawings for an Inlaid Tray, to be constructed as follows:

The panel is to have an inlaid border and centre, and to be enclosed in a raised framing, the latter to have mitred, mortised, and tenoned joints.

*Benchwork.*—Make the tray in accordance with your drawings.

### Questions.

1. Draw illustrations of several common forms of 'mouldings,' giving each its respective name.
2. What are the distinguishing features of Roman and Grecian 'mouldings'?

## LESSON 56a.

### Induction Coil.

*Explanation.*—The base is of soft pine. The binding-posts (AA) are shown in the drawing as passing through the board, so that the connections shown by dotted lines may be placed in grooves, cut on the under side. These binding-posts can be bought; or brass end-fasteners from sash curtain-rods can be used as substitutes.

The current-breaker (C) is cut from a piece of soft tin. One end is soldered to a piece of soft iron (D), and the other to the head of a machine screw (E).

The ends of the spool for the coil are of thin white-wood. Besides the holes for the core, there

are two small holes in each end through which the current-wire makes entrance and exit. These end-pieces are fastened to the ends of a hollow paper cylinder by means of glue. This cylinder (G) is made of layers of coarse wrapping-paper, cut to a length and wrapped around a lead-pencil, and pasted so as to make it stiff and strong. The

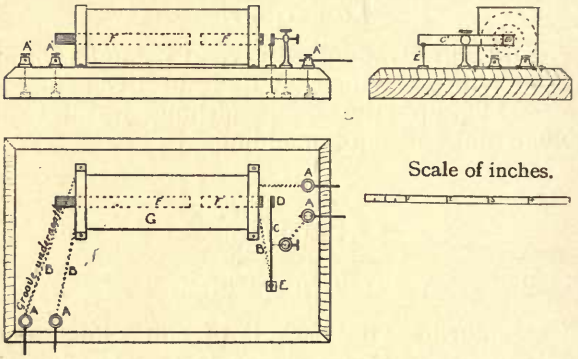



FIG. 117.—INDUCTION COIL.

AA, Binding posts; BBB, grooves underneath in which are placed connecting wires.

primary coil is wound with No. 12 induction wire, the ends extending through the wooden end-piece. A layer of paper is wrapped round this coil before a secondary coil of No. 40 induction wire is wound. A piece of brown paper is wrapped about every second layer of the secondary coil. The secondary coil, after being wound, is neatly covered with brown paper, pasted in place before the coil is

fastened to the base. The poles are made by cutting two cylinders off a broomstick to a length of 4″. A brass screw-eye is fastened in one end of each cylinder, to which the wires are attached. The cylinders are covered with tinfoil, which is also wrapped around the brass screw. The lathe (Exercise 58a) is used in the winding of the coils. The core is of soft iron in two parts (FF), in order that the strength of the current may be regulated thereby.

## LESSON 57.

### CRUMB-TRAY.

*Drawing.*—Prepare working drawings for a Crumb-Tray, and make a floral design for the

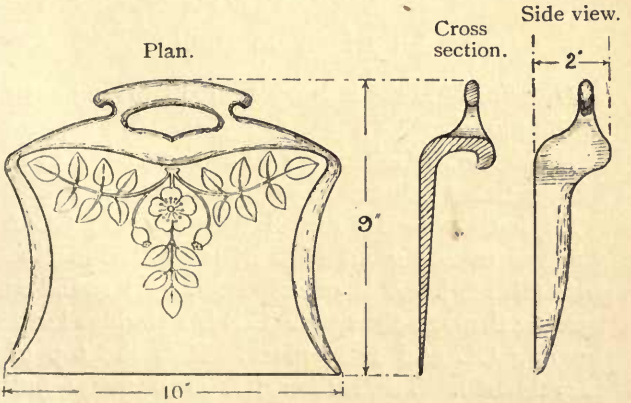



FIG. 118.—CRUMB-TRAY.

blade of the tray which shall be suitable for inlaying.

*Benchwork.*—Execute the Crumb-Tray and inlay the floral design.

### Questions.

Define the term 'seasoning,' as used in reference to the preparation of timber, and explain clearly the reason for the process. State the advantages and disadvantages of artificial seasoning, and briefly describe the chief chemical processes employed in preserving timber from the effects of variable climatic conditions, the attacks of insects, etc. (C. and G., 1907.)

## LESSON 57a.

### An Electric Bell.

*Drawing.*—Make a dimensioned working sketch of the model.

*Benchwork.*—Collect together the parts; fit and fix together as shown in your sketch.

*Explanation.*—BB are binding-screws; CC the wooden reels, wound with coils of fine insulated wire (No. 12). D is of soft iron, bent round and passing through the reels. E is the wooden keeper, holding CC and D in place. R is the top of a bicycle bell. The striker (G) is a metal bullet soldered to the bent arm attached to J, which is

the armature of soft iron. H is a piece of watch-spring soldered to J and the angle piece M. L is

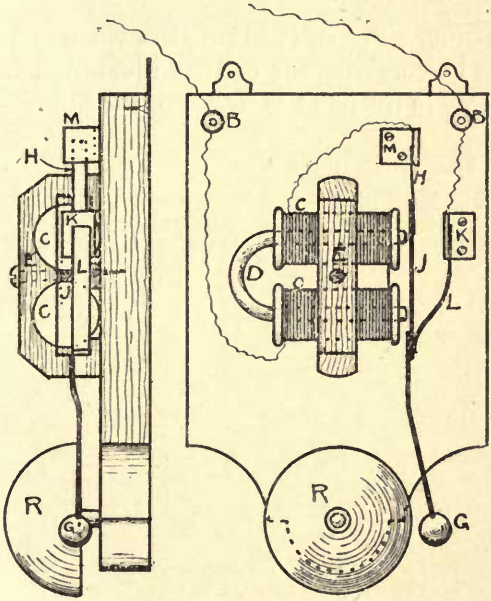



FIG. 119.—AN ELECTRIC BELL.

BB, Binding-screws; CC, wooden reels wound with coils of fine insulated wire; D, soft iron bent round and passing through reels; E, wooden keeper holding CC and D in place; R, bicycle bell top; G, metal bullet soldered to metal striker secured to J; J, armature of soft iron; H, piece of watch spring soldered to J and angle piece M; L, spring soldered to angle piece K; K and M, metal angle pieces.

a bent spring attached to K and just touching J. K is a metal angle piece.

## LESSON 58.

### Drop-Leaf Table.

*Drawing.*—Prepare working drawings of a Table similar in construction to that illustrated in Fig. 120. Make freehand sketches of the joints.

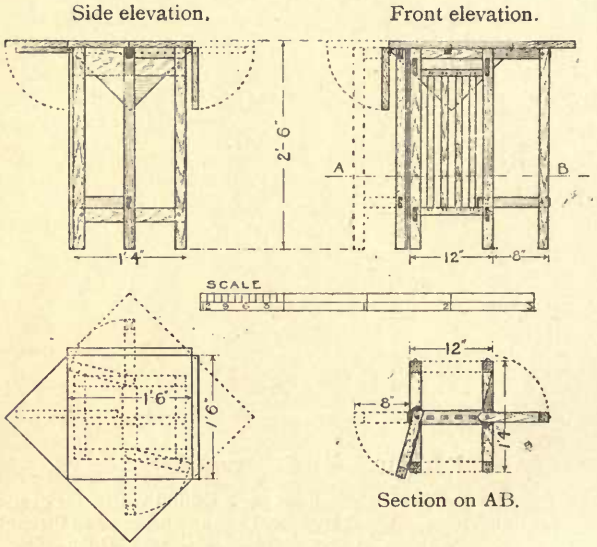



Fig. 120.—Drop-Leaf Table.

*Woodwork.*—Execute the Table in oak, and when it is completed fume and wax-polish it.

## LESSON 58a.

### Winding Machine for Electrical Reels, etc.

This machine, though specially suited for winding electrical reels of varying lengths, may be used for several other purposes—viz., (1) for winding twine; (2) as a windlass for hoisting purposes, or for kite-flying. In the latter case it would need

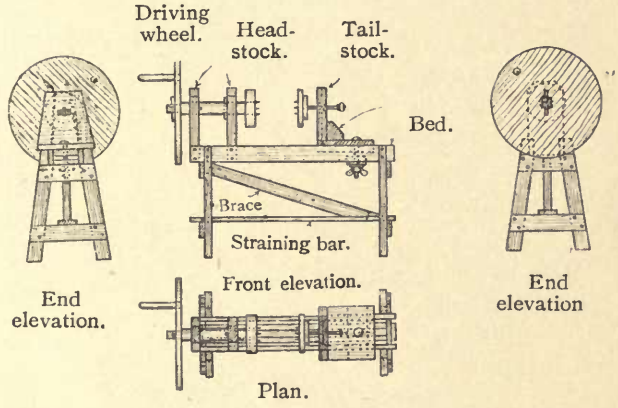



Fig. 121.—Winding Machine for Electrical Reels.

anchoring down to the ground. By a little alteration it could be adapted to other purposes.

*Drawing.*—Prepare working drawings of the Winding Machine.

No dimensions are given, as these, as well as any necessary structural alterations, depend on the several purposes for which the machine may be used.

*Benchwork.*— Make the Winding Machine to accord with your drawings.

## LESSON 59.

### CHAIR.

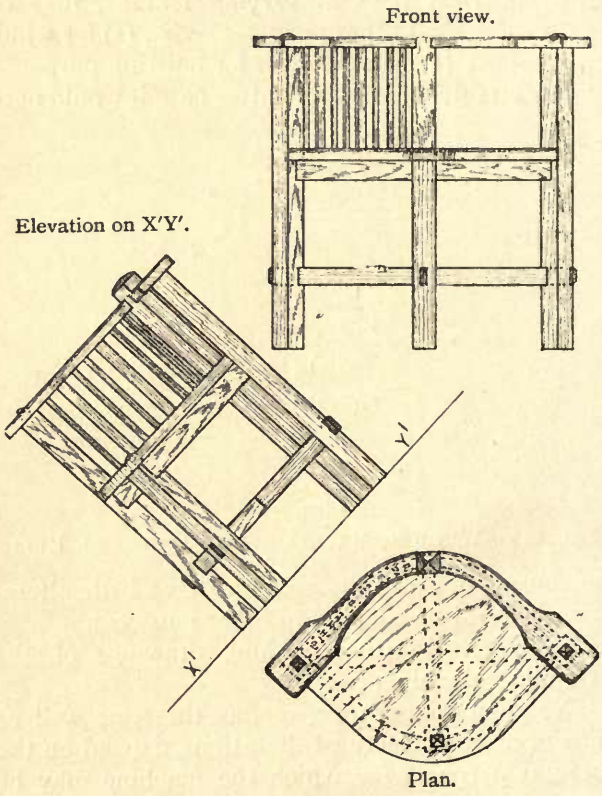



FIG. 122.—CHAIR.

Make designs and working drawings for a Chair to harmonize with the Table in Lesson 58. Some idea of a Chair of the nature required is shown in Fig. 122.

Make the Chair in oak, and fume and wax-polish it.

## LESSON 59a.

### Original Scientific Model.

Work out, by notes, sketches, drawings, and by a model in material, some application of a Scientific Principle in which you are interested.

## LESSON 60.

### Original Model.

Collect together from books, drawings, or actual examples, all the information you can upon one of the following or similar subjects. Illustrate your data by sketches or working drawings, and make a complete model of the subject.

1. The construction and working of railway signals, by day and night.
2. The construction of railroad tracks, points, platforms, etc.
3. The construction of a tube railway.
4. The construction of a railway carriage, waggon, automobile, or other vehicle.
5. The construction and working of canal locks.
6. The history and construction of printing-presses, type, blocks, etc.

7. The construction and working of cranes—jib, derrick, travelling, etc.

8. The construction of some piece of building construction—*e.g.*, floor, roof, door, window, stair, trusses.

9. The construction and working of a lift.

10. The construction of a windmill.

11. The construction of bridges.

12. Pile-driving.

13. Piers.

14. Ships and boats.

15. Workshop, with power.

16. Pumps.

17. Furniture (domestic or office).

18. Stables and their fittings.

19. Toys and games.

20. Photography and its accessories.

21. Optical lantern and its accessories.

22. Pattern making and moulding.

23. Gates, stiles, and fencing.

24. Farm implements and machinery.

25. Farm buildings.

25. Horticultural buildings and implements.

27. Railway turn-table.

28. Construction and flying of kites, balloons, parachutes, etc.

29. A colliery.

30. Musical instruments, etc.

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